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MIGRATION POLICY CENTRE

EUROPEAN UNIVERSITY INSTITUTE, FLORENCE

ROBERT SCHUMAN CENTRE FOR ADVANCED STUDIES

MIGRATION POLICY CENTRE (MPC)

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RESEARCH REPORT, MPC RESEARCH REPORT 2012/11

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The Migration Policy Centre (MPC)

Mission statement

The Migration Policy Centre at the European University Institute, Florence, conducts advanced research on global migration to serve migration governance needs at European level, from developing, implementing and monitoring migration-related policies to assessing their impact on the wider economy and society.

Rationale

Migration represents both an opportunity and a challenge. While well-managed migration may foster progress and welfare in origin- as well as destination countries, its mismanagement may put social cohesion, security and national sovereignty at risk. Sound policy-making on migration and related matters must be based on knowledge, but the construction of knowledge must in turn address policy priorities. Because migration is rapidly evolving, knowledge thereof needs to be constantly updated. Given that migration links each individual country with the rest of the world, its study requires innovative cooperation between scholars around the world.

The MPC conducts field as well as archival research, both of which are scientifically robust and policy-relevant, not only at European level, but also globally, targeting policy-makers as well as politicians. This research provides tools for addressing migration challenges, by: 1) producing policy-oriented research on aspects of migration, asylum and mobility in Europe and in countries located along migration routes to Europe, that are regarded as priorities; 2) bridging research with action by providing policy-makers and other stakeholders with results required by evidence-based policy-making, as well as necessary methodologies that address migration governance needs; 3) pooling scholars, experts, policy makers, and influential thinkers in order to identify problems, research their causes and consequences, and devise policy solutions.

The MPC's research includes a core programme and several projects, most of them co-financed by the European Union.

Results of the above activities are made available for public consultation through the website of the project: www.migrationpolicycentre.eu

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1. Introduction

The attempt to attract highly-skilled migrants relies on the underlying hypothesis that highly-skilled migrants contribute to innovation and economic development in the economically more advanced destination countries.

The European Council with the Lisbon strategy launched the competitiveness objective and the European Commission with the Blue Card Directive inside the Global Migration Approach provides the instrument to foster competitiveness through highly skilled migration, defined as those who are tertiary educated. The European Commission strategy Europe 2020 again gives priority to growth and innovation.

The presence of the highly skilled among foreign workers is not evenly distributed among the Member States, it varies from 10.4% to 34%[1], and but the forecast of demand for highly skilled workers in 2020 will increase by 8% in the occupation structure.[2]

Jonke (2011) in his stimulating paper on Immigration and the European Innovation System provides many arguments on the effects of highly-skilled migrants on innovation and growth and on the most appropriate migration policies which can facilitate growth. But empirical evidence of this relation for the European case is an issue that remains largely unexplored.

The few papers that have addressed the issue of the contribution of immigration to innovation do not find evidence of a positive effect. For example, Ortega Peri (2011) using a large sample of thirty OECD countries 1980-2007 suggests that migration has a negative effect on TFP (Total Factor Productivity). Also Peri (2011) shows that highly-skilled migrants[3] do not affect innovation in Europe.

On the other hand, Ozgen, Nijkamp, Poot (2011) find that is not the size of the foreign community, but its variety which spurs patent applications in Europe.

The first (Peri Ortega, 2011 and Peri, 2011) result is at the aggregate level of the entire economy. It can be argued, however, that the different sectors of the economy differ substantially in innovation rates and R&D intensity and, accordingly, the impact of immigration may differ across different industries.

The second (Ozgen et al. 2011) stresses the positive role played by the variety of migrant origins in spurring innovation which could just be the result of the concentration and specialization of migrants in different sectors, which complement the other in a synergic way.

For these reasons we analyze the effect of immigration skilled and unskilled on innovation at the sectoral level in three large European countries, 1994-2007. In addition we control for age effects and for the economic determinants of innovation like R&D and capital investment and openness to trade. This direction has been already pursued by the European Competitiveness report 2009[4] of the European Commission with analysis restricted to migrant share.

Sectors are defined at the two digit level of the NACE classification and different measures of innovation are selected. In particular we focus on TFP derived from the KLEMS data and from patents applied at the European Patent Office.

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[1] OCDE, 2009, International Migration Outlook, SOPEMI 2009, Paris.

[2] Or 16% of the qualification structure , 10 million highly-skilled jobs, see CEDEFOP 2010, Skills Supply and Demand in Europe.

[3] As a measure of innovation they use the Total Factor Productivity.

[4] See section 3 Volume II.

The share of foreign workers or the share of foreign skilled workers are, however, unable to tackle the entire role of human capital in the innovation process, because other characteristics of human capital play a fundamental role: age, education, occupation in addition to migrant and native.

The **age** variable proxies the risk propensity which is strongly correlated to the propensity to innovate and also the depreciation of whatever human capital the worker holds which is composed of a physical component but also in knowledge terms.

The level of **education** measures the human capital of the worker and its propensity and the possibility of innovating. With aggregate data it is impossible, however, to catch the experience of a job which is part of the creation of human capital, but controlling for age we can at least capture the decline of the productivity of human capital or its accumulation which can increase total human capital as the worker ages.

Education level is, nevertheless, not a good proxy of what the worker does, because there is a large experience of **brain waste** among natives and even more among foreign workers where human capital is not perfectly transferable or because of discriminatory behaviour in the labour market. Thus when **occupation** by skill is possible it will be used to control for the contribution to innovation by workers employed in highly-skilled positions.

Last but not least the **migrant and natives** distinction will be made to control for the contribution of the foreign labour force.

Unfortunately the EULF survey does not provide a detailed sector (two digit NACE) disaggregation for the foreign workers, thus the focus will be on the three most important countries cases: the United Kingdom, Germany and France. In these three countries the demand for highly-skilled workers and for innovation is not a recent phenomenon. The information on natives and foreign employment by skill occupation (ISCO) and level of education (ISCED) will be derived from the national labour force survey which also provides information for the NACE two digits sector.

The link between migration and innovation is uncertain and empirically documented better in the US while the link between innovation and growth or competitiveness seems more rooted in the growth and innovation literature (e.g. Aghion and Howitt, 1992, Fagerberg, 1999,).

2. Measuring innovation

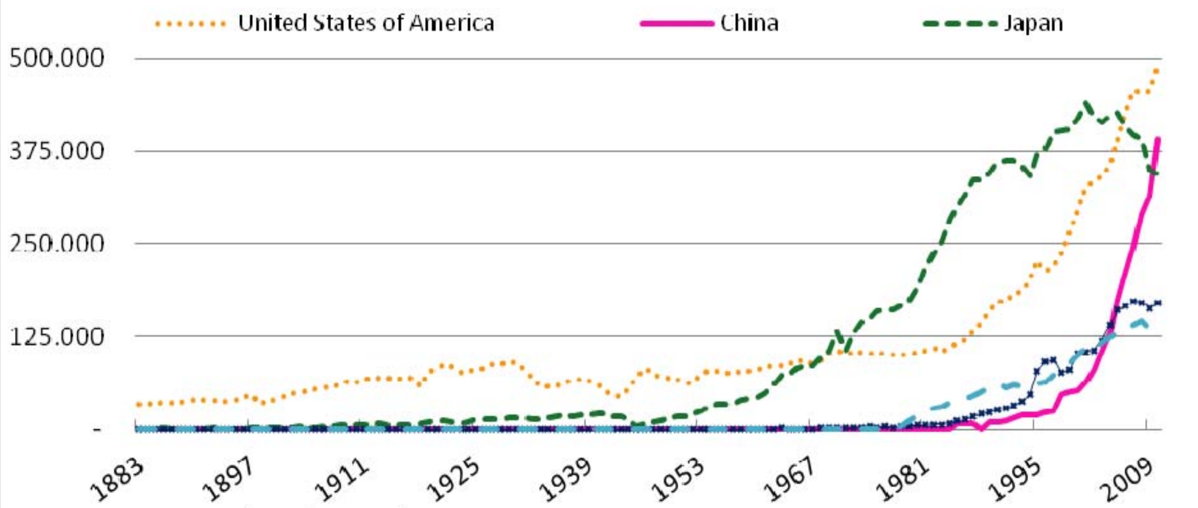
The recognition that innovation and technical change are key components of economic growth has pushed economists to look for appropriate indicators. This is a daunting challenge since innovation is a multi-faceted phenomenon and knowledge creation does not always leave a paper trail. For this reason we chose to use two different indicators typically considered in the economic literature.

One of the most popular indicator of innovation is the number of **patents** applications at industry or country level (e.g. Furman et al. 2002). Patent data are typically considered an extremely important indicator of innovation activity and they are extensively used in the economic literature. They provide valuable information on the technological activities of inventors and companies across countries in specific technological fields for long time series (Pavitt, 1985; Pavitt, 1988; Grupp, 1990 and Griliches 1990). The economic literature has validated the use of patents showing that there is a high level of correlation with R&D activities at the firm level (Griliches, 1990) and that patents are a good proxy for the technological effort of companies and non-firm organizations aiming to create new products and processes[5]. The use of patent applications at the European Patent Office is very diffused.

[5] The use of patents at the aggregate level has important limitations: (1) the technological and economic value of patents varies considerably (e.g. Shankerman and Pakes, 1986): many patents have low economic and technological value, while a few of them are extremely valuable; (2) many inventions are not patented: even if patents are increasingly used by companies, the evidence provided by many surveys of R&D managers indicates that, in many sectors, patents are not

International patent applications are costly and, therefore, using patents we selected inventions with market potential.

Figure 1: Trend in patent applications at the top five offices, 1983-2010.



Source: WIPO Statistical Database, October 2011.

In recent years, with global harmonization in the intellectual property systems, many countries increased patenting activities, in particular the ones with relatively higher *per capita* growth rate. Even if patenting levels are not directly comparable across national patent offices because of different registration systems and legislation, Figure 1 gives an interesting snapshot on the relative dynamics of patenting activity in the main world regions. The leadership of the US was challenged by Japan in the 1970s, and the rapid growth of patent applications at the Chinese and Korean patent offices in the last 20 years are particularly impressive and confirm the role of these emerging markets in the global technological arena. At the same time these figures explains why in Europe the search for competitiveness and innovation is a top priority.

Following Furman et al. 2002, in this paper **Patents** are used to approximate the **national innovative capacity** of countries. Differently from Furman et al. 2002 we study the innovative capacity at the sectoral level and explore how it is affected by the characteristics of human resources (among many other factors) and their demographic trends.

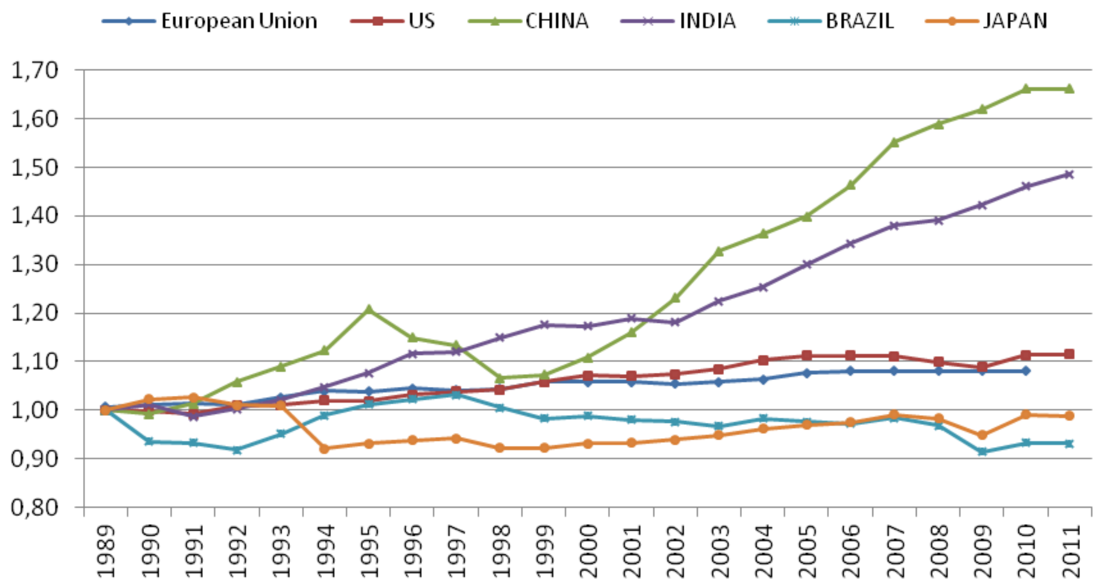
An additional measure of innovation is the growth of **Total Factor Productivity** (TFP). Assuming a traditional Cobb-Douglas production function (eq. 1) TFP is associated to the so called Solow residual: A, which represents the component of the total output which is not explained by the direct contribution of Labour (L) and Capital (K).

(1) $Y_t = AL^{\alpha}K^{1-\alpha}$

(Contd.)

considered the major source of profit from new products and processes (e.g. Cohen *et al*., 2000); (3) companies show significantly different propensities to patent across sectors. Finally, like R&D measures, patents tend to be a better proxy for technological activities of large firms. Small firms tend to have a lower propensity to patent because – all things being equal – the use of intellectual property rights requires high fixed costs of implementation and scale (Bound *et al*. 1984, Patel and Pavitt, 1994). Therefore, the size distribution of firms may have an important effect on the aggregate number of patents at the national level.

Figure 2: Total Factor Productivity growth in the largest countries.



Source: The Conference Board Total Economy Database and EU KLEMS Database. 1989 arbitrarily set to 1, the time series are constructed in the following way: A(t+1) = A(t) (1+ΔA(t)/A(t))

Solow (1957) defined the growth of TFP (ΔA) as "technical progress in its broadest sense" ; Abramovitz (1956) famously named it the "measure of our ignorance"[6], because it is obtained as a residual after subtracting from the growth rate of value added the growth rates of capital and labour, weighted by their respective shares in the value added aggregate.

$$\Delta A/A = \Delta Y/Y - \alpha(\Delta L/L) - (1-\alpha)(\Delta K/K)$$

Both Solow and Abramovitz stressed too the lack of a specific theory accounting for its dynamics[7]. Indeed, A is sensitive to many different improvements in production that can be guided by changes in the quality of labour by age, education, skill and occupation and migrant and native (Jorgenson and Griliches, 1967). Denison (1985) in calculation attributes 16% to increases in education, while endogenous growth models underline the role of human capital by changing the focus from the quantity of labour to the quality of labour, highlighting the role of skills within the workforce (Romer, 1990). Accordingly in our analyses we will not only consider skill composition but also the age, education, occupation and nationality of the labour force. Figure 2 above shows that the growth rates of TFP vary widely among countries: as in the case of patents, the steep growth of East Asian countries such as China and India from the mid-nineties onward is clearly visible using this measure. We use Total Factor Productivity to measure not only the innovative investment of a country or a sector (mainly proxied by patents), but also the effectiveness of such an effort in economic terms.

We use the EU-KLEMS dataset which provides, for all European countries, an accurate measure of multifactor productivity (O'Mahony, Timmer, 2009). Klems TFP growth series are estimated from micro data and aggregated at the sectorial level. For this reason these data are particularly suitable for our kind of sectoral level analysis.

[6] Prskawetz A., Mahlberg B., Skirbekk V., Freund I., Winkler-Dworak M.2006, pag.4.

[7] Other shortcomings from the use of growth in total factor productivity depend on underlying assumptions about the presence of constant returns to scale in the economy and from the adoption of the Euler Theorem according to which the overall compensation of labour equals its marginal productivity. Notwithstanding all these simplifying assumptions TFP growth still remains a good proxy of the share of growth of a firm, country or region which does not depend on the increase of standard productive inputs, and hence is typically associated with innovation.

In the literature also the expenditures in research and development (**R&D)** is often used as a proxy of the innovation potential. However in our analyses R&D will be used as an input in the production of innovation instead as a final indicator; rather we will use it to identify the more innovative sectors, following the well known literature on High and Low tech sectors (OECD, Hatzichronoglou, 1997).

3. Survey of EU and USA literature

3.1. The effect of education on innovation

The effect of higher education on innovation is very well studied and with very few exceptions there is evidence of a positive relation. The sectors which produce innovation use highly–educated workers in Science and Technologies, but also sectors which only make use of innovations produced elsewhere need highly- educated workers in order to favour its implementation (see Lutz et al, 2008).

A less straightforward relation exists when the field of education is taken into count. Specific fields of education are more conducive to innovation because they are more related to the production of innovative processes (Antonelli, Fassio, 2012). At the same time the "Endogenous growth" literature stresses that human capital stimulates aggregate productivity independently of specific fields because the diffusion of innovation requires higher education among workers (Carnoy and Marenbach, 1975; Hanushek and Woessmann, 2008; Di Liberto, Pigliaru, Chelucci, 2011). On the one hand, only S&T education seems conducive to innovation, on the other, without the diffusion of more general higher education it is impossible to diffuse innovation and thus higher education in general plays a positive role in total production growth.

A second relevant issue is the quality of education which varies a lot within a country and across countries. The number of education years could be a misleading indicator and could produce distorted results as Razin and Wahba (2011) show. The use of an appropriate weight which controls for education quality as provided by the PISA dataset is a possible solution.

3.2 The effect of age on innovation

The effect of age on innovation and productivity is even less straightforward than the effect of education.

The Human Capital theory (Becker, 1975) shows that at the end of the education period workers reach their maximum productivity which depreciates as working time goes on. This result can be imputed to the decline in cognitive abilities for older individuals found in laboratories as Oberg already stated in the 1960 (p. 246) and that was revised by Jones in 2005 (p.10). Workers, however, can make up for their obsolescence in knowledge and productivity by investing in additional forms of education or on-the-job training. The accumulation of additional human capital contrasts the depreciation of initial capital. This practice is very common, for instance in the EU27, where 30% of the workers in the 40-54 age bracket were involved in 2005[8] in continuing vocational training (Jones Hayden 2009).

The investment in additional human capital accumulation is larger in the initial phase of a working career because the worker can reap a return on it for many years, while this is no longer true when the worker is close to the end of the working life because the cost incurred during the investment phase is higher than the benefit.

The wage-productivity profile of a worker during his working life increases slowly over time, peaking around 40-45 and declining later on.

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[8] Calculation of the DG Employment based on the fourth European Working Condition Survey.

It is very difficult to measure worker productivity and workers' investment in training on the job across many countries and industries. As a consequence our research uses age to proxy the evolution of worker productivity. If productivity favours innovation we expect, according to the Human capital theory, that the age variable has an inverted U shape or better that the productivity is proxied by the decline side of the U function.

Accordingly concerns emerge for the future innovation capacity of Europe as an aging continent with long-term below replacement fertility and with a continuous rise in life expectancy. The strategy to enhance European global competitiveness looks particularly challenging because competitors are countries with a larger amount of young population and with a very rapid increase in higher education. According to Human capital theory, the fear for the future competition is well routed and the only policies that make up for human capital decline can reduce the loss of competitiveness[9]. However the research on Nobel prizes and innovation (Jones, 2010; Levin, Stephan 1991, Frosch, 2011) suggests that the relationship between the generation, diffusion and the adoption of innovative products, services and production technology and age is much more complex. In knowledge intensive sectors inventors are younger, while in more experience-based fields inventors are older. Furthermore Feyrer[10] points out an "age dividend" which stresses that the reduction in innovation can be imputed to the reduction of the labour force not its aging because the older workers produce more innovation.

Thus the age innovation distribution of individuals seems bimodal: the first mode is at early age after the end of education when innovative risk propensity dominates the results; and the second mode comes later when the higher ability, which includes also team and organizational abilities, accumulated during working life, leads to the results. This suggests that the introduction of the age variable to proxy innovation ability will produce an increasing profile at a lower pace which could be proxied by the rising side of an U shape profile and this implies that older workers are more productive and enhance competitiveness and that their future capacity to innovate is much less endangered.

3.3 The effect of skilled occupation on innovation

The distinction between high education and highly-skilled occupation belong to the tradition of labour economic labour literature where the investment in education has to find an appropriate remuneration and the employment in appropriate jobs suggests an incorrect educational investment. In the case of women and foreigners, frequently, discriminatory behaviours are also reported and "brain waste" is used. As mentioned before the issue is quite complex because the same number of years of education do not necessarily means the same level of human capital. The field of education first and then the quality of education are fundamental in determining the specific productivity of the worker and the issue of over education is receiving more and more attention as evidence becomes available of an increased mismatch between education and the jobs available in the labour market.

With this proviso the limitation of the analysis of the effect of workers in highly-skilled occupation on innovation has advantages and disadvantages:

I. by limiting the analyses to the highly educated in highly-skilled occupation it eliminates the over-educated and presents a more precise relationship between innovation and human capital;

II. by doing so the aggregate effect of an increase in the highly educated, even if over educated, is not controlled while it could be the dominant component;

III. last the choice of using workers with highly-skilled occupations will capture the specific structures of the human resource organization of the firms and of the economy which can be more vertical or more horizontal and which have the same productivity performance.

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[9] See Jones and Hayden 2009.

[10] See pag.90,92 and the detailed survey by Frosch.

3.4 The effect of migration on Innovation

1. Migration and innovation

a. The link between innovation and migration in Europe have been tested at the country level by Ortega Peri (2008) and Peri (2011) using the traditional approach that builds on the growth of **Total Factor Productivity**. They compute the Solow residual and regress its rate of change on the aggregate migration rate controlling for the share of highly-skilled migrants. In both cases no significant effect is detected on the estimated residual or a negative effect. The endogeneity problem of the migration data is solved by a first stage regression which uses a gravity model of bilateral migration.

The result is, in a certain way, unsurprising because innovation research stresses the link between innovation and highly-skilled workers, and foreign highly-skilled workers, though only in the High Tech sectors. The spillovers from innovation can penetrate all the economy but only as a by product of the initial effect. The choice made by Ortega Peri is, instead, clear, they put together low- and highly-skilled foreign workers and favour innovation in all the economy, but they found no effect[11]. Also Peri (2011) who uses highly-skilled migrants finds no effect on the TFP at the aggregate level and also his estimates suffer the same limitation.

The Ortega Peri approach is in line with the new literature that stresses the significant complementarity of unskilled workers versus skilled ones employed in a different sector (Cortes Tessada, 2011; Baroni Mocetti, 2011; Farré et al, 2011; Romiti Rossi 2011[12]). We are sympathetic to this view and, at the same time, we explore the possibility of finding a relationship between migration, TFP and innovation in the High Tech sectors and only afterwards searching for the systemic effects[13] of migration.

b. The link between migration and patents[14] is analysed by Ozgen, Nijkamp and Poot (2011) in Europe[15]. They use a measure of all patents for 170 European regions explained by growth rate, population, human resources in S&T, accessibility index plus the share of migrants and a diversity index calculated among migrants. The authors are only interested in the migration side of the tests, thus they stress the importance of the diversity index versus the share of the migrants. It is not the size of the migrant population which matters, but their composition. As in the previous case the results are very interesting but they do not answer the question of whether the inflow of migrants is positive for innovation? The size variable is not significant, information is not unfortunately available for the immigration year, and also the average age of the migrants are not given, thus the variety index does not catch the young age of the migrants or their sector specializations.

2. Is there any link between innovation and migrants and migration policy?

This field has been developed in the US by Kerr Lincoln (2010), who studies the link between patent and a special visa policy (H-18) which favours the entrance of foreign workers in science and engineering and who finds an increase in innovation measured as patents. The focus of this paper is on the role of the supply of Human capital in science and engineering which can spur innovation without crowding out natives. As well Hunt and Gauthier-Loiselle (2010),between immigration and patenting

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[11] They use the OCDE-STAN data.

[12]Cortes T., Tessada J., 2012, Low-skilled immigration and Labour supply of Highly Educated Women, American Economic Journal: Applied Economics; Barone G., Mocetti S., 2011, With a Little Help from Abroad, Labour Economics, 18, 664-675; Romiti A. and Rossi M. 2011, Should we Retire Earlier in order to Look After our Parents? The Role of Migrants, CeRP Working Paper http://works.bepress.com/agnese_romiti/5

[13] Migration has been instrumented with the number of McDonalds restaurants.

[14] Source EPO by IPC (International Patents Classification)

[1515] They use the EUROSTAT General and regional database, 12 EU countries, 170 regions NUTS2 rates[16] using state variation , which find a substantial crowding in effects for native scientists and engineers. Migrants have a positive effect not because they are innately more able than natives but because of their greater share with science and engineering education. Chellaraj, Maskus, and Mattoo (2008) also find a strong complementarity. In particular they find that the presence of foreign graduate students has a significant and positive impact on both future patent applications and future patents awarded to university and non-university institutions.

In all these works there is an intrinsic difficulty in identifying causality: on the one hand, migrants can contribute to the innovative and scientific activities of the host countries, on the other migrants are attracted to productive environment with important sorting effects. Typically innovation activities, measured in term of patents, could create the demand for foreign nationals. In principle it would be important - in order to understand the impact on innovative capacity of the presence of foreign nationals in HT sectors – to isolate the pull factors from the push factors in their countries of origin.

The analysis of patents in the US (by Kerr, Lincon 2010) by foreign nationality Indian and Chinese suggest that the second dominates.

4. The model

In addition to the traditional variables used to explain innovation, like R&D and capital investment, we explore whether such human capital characteristics as age, education and occupation and migrant and native play an independent role in spurring the innovative capacity of firms.

In this paper two quite different theoretical and empirical approaches are followed.

4.1 Patents: annual flow, and annual stock for the manufacturing sector.

The first specification is narrower than the second not only because it refers only to the manufacturing sector but also because it proxies innovation potential. Here we are not directly measuring the economic effect of innovation, but rather the ability of sectors to build innovative capacity, proxied by the number of patent applications at the European Patent Office.

Our model draws on similar models aimed at explaining the innovative capacity of countries or sectors (Furman et al, 2002). We test whether the annual flow of patents (Å) in year t and sector j is explained by the lagged annual investments in fixed capital (K), the lagged yearly expenditures in Research and Development (R&D), a lagged measure of the openness to trade of a specific sector (OT) and the lagged human capital characteristics (H) in that specific sector j. Being the annual number of patent an annual flow as in all the growth model, we also control for the stock of patents in the previous year (A). A measures the stock of prior ideas and prior research. Note that if the coefficient of A is positive this means that the stock of prior ideas and prior research increases R&D productivity (this is also called the "standing on the shoulders of giants" effect), but if the coefficient is negative. This would be a sign of new inventions becoming increasingly difficult.

$$\text{Å}_{j,t} = Hj_{,t}^{\alpha} K_{j,t}^{\delta}\, R\&D_{j,t}^{\lambda}\, T_{j,t}^{\beta}\, A_{j,t-1}^{\phi}$$

The model is specified by sector j and time t and controls for R&D inserted as controls.

Taking logs we have:

$$L\,\text{Å}_{j,t} = +\delta LK_{j,t-1} + \lambda L\, R\&D_{J,t-1} + \alpha LHj_{,t-1} + \beta\, T_{j,t-1t} + \varphi L\, A_{j,t-1} + \beta \text{ time } D + \gamma \text{ SecD } \varepsilon_{j,t}$$

A different specification of this model will be used: we will start by checking the impact of skilled and unskilled workers, without distinguishing between natives and migrants, then we will test the

[16] US Patent and Trademark Office

correlation between age and the number of patents, finally we will check for the impact of skilled and unskilled workers distinguishing between natives and migrants and also checking for the effect of age among migrants and among natives

The endogeneity of the Human capital variable is probably less severe in patent specification and the use of different lags is a solution to inquire into the correlation of the factors which affects innovation. This also controls for a possible reverse causality effect but an accurate modelling of endogeneity is needed to inquire into the causality between human resource and innovation which for the moment is postponed.

4.2 Total factor productivity

As already noted we also proxy the innovation performance of a country with the growth of TFP. In this section we consider innovation in terms of the productivity effect that it exerts on the performance of national sectors. Taking advantage of the data provided by the EU-KLEMS database we use the growth rate of TFP for all the sectors of the economy. Hence our analysis includes all sectors of the economy, including primary sectors, manufacturing and services sectors.

The growth of total factor productivity (Å) in a given sector J at a given time t is considered to be a function of the level of human capital Hj,t and of its growth rate ΔHj,t where time D and sector D are time dummies and sector effects.

$$\Delta L\AA_{j,t} = c + \gamma H_{j,t} + \delta(\Delta H_{j,t}) + \beta timeDs + \gamma sectD + \varepsilon_{j,t}$$

For the manufacturing sector the increase in expenditures in R&D, and the openness to trade could be included.

The inclusion of both the levels of Human capital (as in Griffith, Redding, van Reenen, 2004) and of the growth rates of its component allows us to refine the analysis implemented by Ortega Peri (2011), in which only the growth rates are considered. In our approach we can measure the effects of the growth of H controlling also for the initial levels of human capital in each sector. Assuming, for example, a negative correlation between the levels and the growth rates of human capital, the exclusion of the former might lead to a typical omitted variable problem, which might lead to a bias in the coefficients of the growth rates. Including time dummies should also prevents us from possible country-wide time shocks, such as institutional changes or economic downturns.

We will use a number of different specifications in order to check the impact of human capital variables on the growth of TFP: first we will test the effect of the growth of migrants on TFP growth, controlling for age, for the share of migrants and for the share of highly educated workers in each sector. Then we will check the impact of the growth of highly-educated migrants and highly-educated natives, checking also for differentiated age-effects. Finally, we will test the impact of young educated workers among migrants and among natives, controlling for skill-intensity, i.e. the share of highly educated migrants on the total number of migrants and the share of highly educated natives on the total number of native workers.

5. The data, trends and empirical analyses

The data used to measure the innovation process are hence two: the yearly number of patent applications at the European Patent Office and Total Factor Productivity (TFP) growth. The analysis is done at the sectoral level for different years, with a panel that varies slightly in three different country cases, the UK, France and Germany, but in general covers fourteen or twelve years from 1994 until 2007.

At the same level of aggregation we have derived, from the national labour force survey for the UK, France and from the Microcensus in Germany, detailed information concerning human capital.

We have aggregated the individual information on the persons employed at sector level and thus obtained the following variables:

$A_{j,t}$ as average age of the workers natives and foreigners employed in the sector j and year t;

$Young\ workers_{j,t}$ as the number of workers younger or equal to 35 years old and 40 years old in Germany in the sector j and year t;

$Tertiary\ educated$ as the number of workers who hold tertiary education (ISCED classification 5 and 6) or 16 years of continued education as is suggested in the case of the UK[17] in the sector j and year t;

$Highly\ skilled\ occupation_{j,t}$ as the number of workers in occupation 1 and 2 or also 3 of the ISCO classification or similar by sector j and year t;

$Migrants$ as the number of foreign citizen or foreign born workers in the sector j and year t.

The analysis should be extended to the distinction between third countries nationals and European workers to better catch the effect of different migration policies and specific migration policies adopted in the countries under examination, but in this preliminary version we use only the distinction between native and foreign[18] .

The appendix provides an extensive description of the data.

5.1. Innovation proxied by the number of patents.

The specification which use the count of patents registered each year covers only the manufacturing sector.

5.1.1. Variables and trends

For all three countries the **Patent** measure is derived from PATSTAT (see the Appendix), which provides by sector and year of the number of patents registered. The conversion of the International Patent Classification to NACE sectors is provided by Schmoch *et al.* (2003). Patents are assigned to countries using the address of the inventors and fractional counting.

Capital flows are proxied by the annual flows of investments at the sectoral level as provided by the OECD STAN data (Structural Analysis database).

Research and Development expenditures j,t by sectors are, instead, provided by the STAN R&D Expenditures database (OECD) by sector and year.

The **Stock of Patents** is obtained as cumulated variables from the annual flows by sector and year using the perpetual inventory method.

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[17] See Manacorda et al. (2012)

[18] The distinction between Western countries and Eastern ones available in statistics is no more appropriate to catch the enlarged Europe.

Figure 3.a. United Kingdom, Patents and Human capital variables.

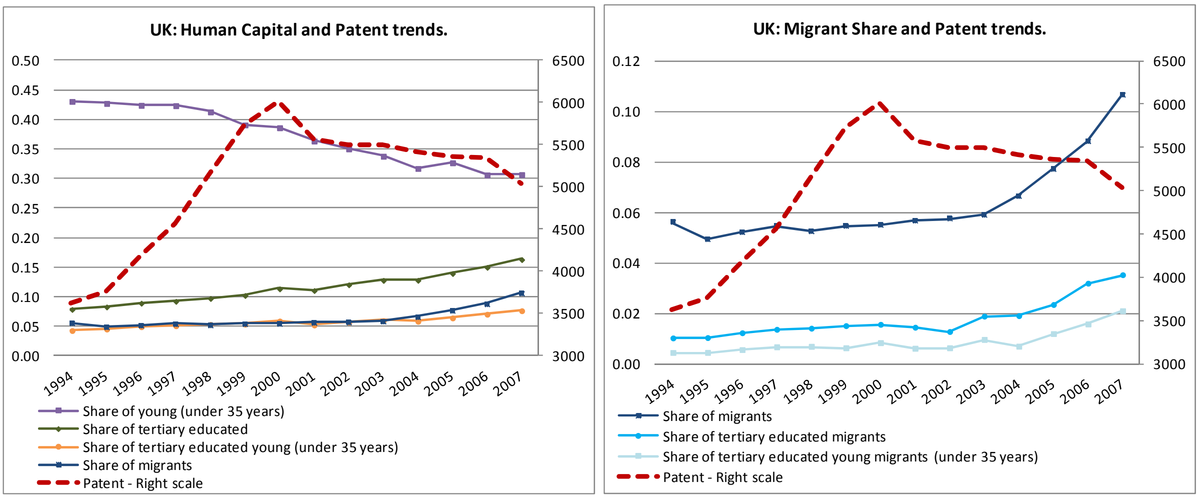


Figure 3.b. France, Patents and human capital variables.

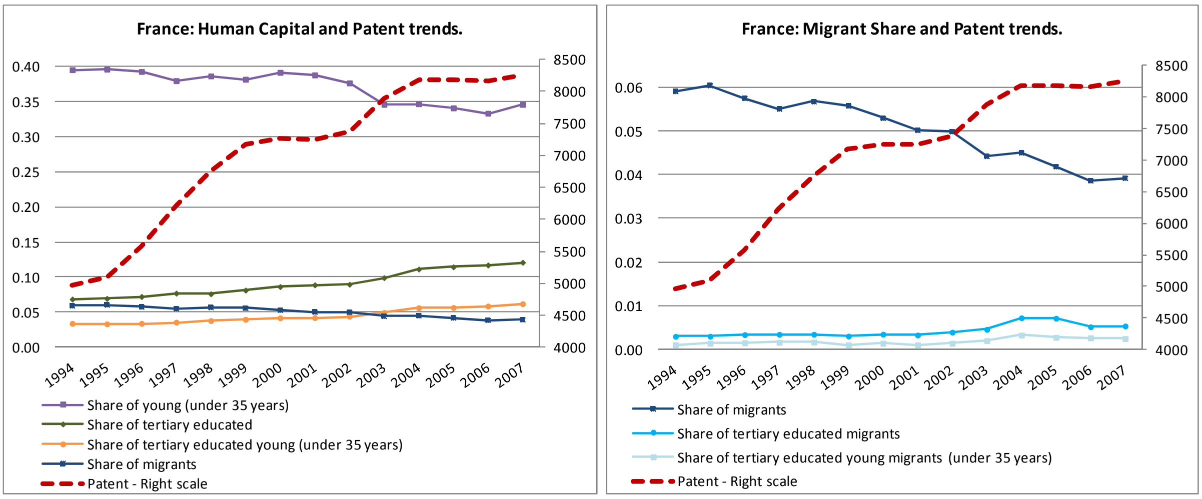
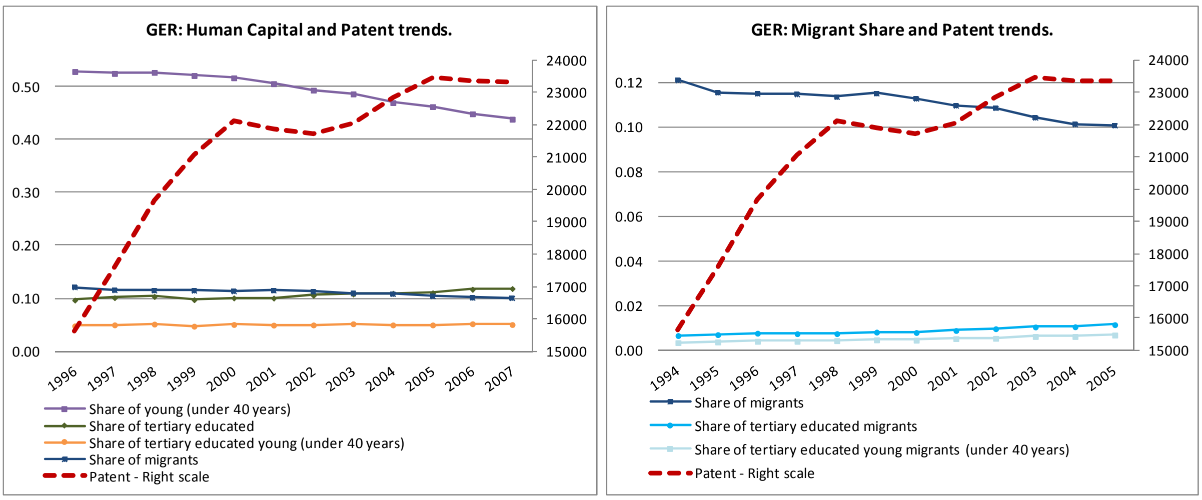


Figure 3.c. Germany, Patents and Human capital variables.



Figures 3.a-b-c show important differences across the three countries considered. First of all of the number of patents registered is different more in level than in trends. Germany which has a very strong manufacturing sector holds a much higher level of patents registered each year, it starts in the 1990s at 15000 and ends at the end of the 2000s at a value of 23000, while France and the UK have, as highest values, respectively 8500 and 6000. What, instead, is common to all three countries is an increase until the year 2000 then in Germany and France growth remains stable until 2003 and then it increases and stabilizes again while the year 2000 is the beginning of the decline in the UK's patenting production which does not return to the year 2000 level.

In all the countries the manufacturing sector experiences aging of the employed, more pronounced in the UK than in France. Also in Germany the share of the young is declining, even if at a different level because, as noted above is referred to workers below 40 years old, but it is declining as well .

The increase in tertiary education is more pronounced in the UK (from 10% to 17%). It is present also in France even if it starts from a lower level 5% and increases to 13%, and in Germany starts from a higher level 10% and increases to 12%.

The share of young workers with tertiary education increases in the UK and France at a lower pace and are even lower pace in Germany.

Let us look at the share of migrants. In this preliminary analyses all non natives are considered migrants thus the pool of workers includes both European citizens who are allowed to move freely inside the European union and third country nationals which have to get through burdensome procedure to enter the EU. In this graphs the share of migrants can include for instance Italians, Poles and Moroccans. The share of migrants in the manufacturing sectors increases only in the UK, while it declines in France and in Germany, even if in Germany, it stands at a high 10%.

The share of tertiary-educated migrants and the share young migrants tertiary educated in UK follow the aggregate pattern, both increase especially in the years 2000 and seems to follow the growing trend in the number of patents. In France and Germany either the share of tertiary educated migrants and the share of young tertiary-educated migrants contrast the general declining migrants employment in the manufacturing sector, but growth there is very limited and does not present any similarity to the patent trend.

5.1.2. The empirical analyses

The empirical analysis that we present here is preliminary, further research is needed, and our present research focuses on the correlation between the human capital variable and innovation proxied by the number of patents registered at European level. The traditional simplistic hypothesis that highly-educated workers favour innovation is questioned and the depreciation or accumulation of human capital which favour innovation is inquired in addition to its ethnic composition.

Fixed effect Poisson estimators are used in estimates concerning the levels of patent applications at the EPO, due to the count-data nature of the dependent variable, while normal fixed effect OLS estimators are used where the growth of TFP is concerned. In order to control for time-trends and country-wide institutional changes year dummies are added in all regressions.

In the first column of Table 3.a for France and the United Kingdom and Table 3.b for Germany the total amount of human capital is included in addition to the capital flows, the annual expenditure in research and development, the openness to trade and the previous stock of patents.

France and the UK are analyzed together because the data coming from the LFS surveys are similar. In Germany data comes from Microcensus which has a different structure and, therefore, we keep it separate. All the variables are significant with the expected sign.

In equation 2 the human capital variable is broken down into highly-skilled (namely Tertiary educated) and Low skilled (all the others) and the traditional results that highly-educated labour favour innovation is strongly supported in the aggregate French and the UK case. But the distinction in the two cases reveals a strong highly-educated effect in the UK and not in France (eq. 3). Also the introduction of the age variable which points to a depreciation or an accumulation effect on human capital is different in the two countries. In France the negative coefficient stresses that the production of innovation is stimulated by the young ages while in the UK we observe a positive age effect: the accumulation of knowledge is more important and innovation is affected in particular by those workers in a more advanced phase of their life, so an “age dividend” is detected.

France has what we can call a ”Young Dividend” while the UK has an “Old Dividend”.

If, as in equation 6, the human capital variable is broken down by nationals and migrants, the picture becomes more complex. In France the skilled natives and unskilled migrants favour the creation of innovations, while the numbers of skilled migrants and the unskilled natives seem to have a negative impact on innovative activities. Conversely in the UK the highly-skilled migrants play a strong positive role in innovation along with low skilled natives.

This result remains strong even if the age variable is broken down by nationals and migrants. In France age has a negative effect on the innovative potential both for natives or migrants, this is why we speak of a “General Young Dividend” in France. On the contrary in the UK age has a positive effect on innovation. This means that the accumulation of human capital dominates the natives contribution to innovation, named Native Old Dividend while the foreign nationals have a positive effect in their young age Foreign Young Dividend. The different role played by highly skilled migrants has also to do with the quality of the highly skilled in the UK. They are selected both by the immigration policy and even before by the educational system which trains the most promising international students in the UK, who are able to affect positively the innovation pattern of the UK more than the natives. While in France young natives and foreign nationals play a positive role in innovation and probably given the less selective immigration policy and the lower quality of human capital. So these results open an interesting question as to why in France we do not observe the ‘experience’ effect in the labour force that characterizes the UK’s regression. In addition the negative effect of skilled migration in France could depend upon different immigration policies and a sorting effect on the quality of highly-skilled migrants. This could also be generated by a different pattern of technological specialization (relative to the UK) within the large sectors we have considered. France could be specialized in technological activities where the foreign highly skilled are less important for innovation.

In Germany the picture is also different from the UK and France. Highly-skilled migrants hold a positive role in innovation as in the UK. At the same time, skilled migrants have no positive role on innovation as in France. A pattern similar to the French one seems to emerge also when we control for age (the accumulation or depreciation effect). The accumulation of human capital seems more important for the low skilled workers, Old Dividend, who play an important role in the manufacturing sector, while depreciation dominates among the migrants, the Foreign Young Dividend.

The age results are confirmed by the specification which uses the young and old migrants and natives populations.

As a preliminary conclusion the UK case is reassuring because the accumulation effect of human capital is important among native workers who are part of an aging population, while the young migrants contribute as well to innovation, and highly skilled migrants even more.

In France, instead, only highly-skilled natives and low-skilled migrants contribute to innovation while both favour innovation in their first phase of work, namely when they are young, the Young Dividend dominate.

Germany is a mix of the two models: low skilled and highly-skilled migrants are the drivers of innovation, but natives are spur more innovation in their younger phase of life while migrants also accumulate human capital and will spur innovation.

In all countries no differential effect is found in the High Tech sector thus the results which distinguish between the manufacturing High and Low Tech are not presented.

Table 1.a. Patent and Human Capital, regression results for France and United Kingdom.

VARIABLES	(1)	(2)	(3)	(4)	(5)	(7)	(8)
$logE_{t-1}$	0.055**			0.063***			
	(0.025)			(0.023)			
$logR\&D_{t-1}$	0.068***	0.028	0.031	0.037*	0.037*	0.050**	0.059***
	(0.024)	(0.019)	(0.019)	(0.019)	(0.02)	(0.02)	(0.02)
logA	0.35***	0.47***	0.48***	0.46***	0.46***	0.44***	0.43***
	(0.047)	(0.036)	(0.039)	(0.036)	(0.039)	(0.04)	(0.041)
logOT	0.086**	0.091***	0.094***	0.094***	0.11***	0.11***	0.13***
	(0.034)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.031)
logK	0.039***						
	(0.014)						
logAge, France				-1.23***	-1.17***	-1.73***	
				(0.34)	(0.34)	(0.37)	
logAge, UK				0.76***	1.00***	0.95***	
				(0.28)	(0.29)	(0.3)	
$logTer\text{-}Edu_{t-1}$		0.034*					
		(0.019)					
$logNoTer\text{-}Edu_{t-1}$		0.022					
		(0.027)					
logTer-Edu, France $_{t-1}$			0.016		0.032		
			(0.025)		(0.025)		
logNoTer-Edu, France $_{t-1}$			-0.00023		-0.023		
			(0.037)		(0.038)		
logTer-Edu, UK $_{t-1}$			0.065**		0.062**		
			(0.029)		(0.029)		
logNoTer-Edu, UK $_{t-1}$			0.088**		0.13***		
			(0.044)		(0.046)		
logTer-Edu Nat, France $_{t-1}$						0.058**	0.056**
						(0.027)	(0.027)
logTer-Edu Migr, France $_{t-1}$						-0.019**	-0.013*
						(0.0075)	(0.0075)
logNoTer-Edu Nat, France $_{t-1}$						-0.095**	-0.15***
						(0.04)	(0.041)
logNoTer-Edu Migr, France $_{t-1}$						0.12***	0.12***
						(0.016)	(0.016)
logTer-Edu Nat, UK $_{t-1}$						0.037	0.036
						(0.028)	(0.028)
logTer-Edu Migr, UK $_{t-1}$						0.031**	0.024*
						(0.013)	(0.013)
logNoTer-Edu Nat, UK $_{t-1}$						0.19***	0.21***
						(0.047)	(0.047)
logNoTer-Edu Migr, UK $_{t-1}$						-0.055***	-0.049***
						(0.017)	(0.018)
logAge Nat, France							-0.99***
							(0.37)
logAge Migr, France							-0.43***
							(0.067)
logAge Nat, UK							0.97***
							(0.29)
logAge Migr, UK							-0.0089
							(0.088)
Observations	295	341	341	341	341	337	337
Number of id	31	31	31	31	31	31	31
Time dummies	Y	Y	Y	Y	Y	Y	Y
Industry dummies	Y	Y	Y	Y	Y	Y	Y
chi^2	1168	2541	2545	2564	2575	2643	2669
significance	0	0	0	0	0	0	0

Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Table 1.b. Patent and Human Capital, regression results for Germany.

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)
logE $_{t-1}$	-0.18***		-0.19***				
	(0.038)		(0.038)				
logR&D $_{t-1}$	0.18***	0.18***	0.17***	0.17***	0.21***	0.21***	0.20***
	(0.028)	(0.029)	(0.028)	(0.029)	(0.029)	(0.029)	(0.03)
logA	0.20***	0.20***	0.21***	0.21***	0.24***	0.25***	0.26***
	(0.039)	(0.039)	(0.039)	(0.04)	(0.04)	(0.04)	(0.041)
logOT	0.21***	0.21***	0.17***	0.17***	0.22***	0.20***	0.17***
	(0.043)	(0.043)	(0.045)	(0.045)	(0.045)	(0.047)	(0.048)
logK	0.0015	0.00064	-0.0067	-0.0072	0.018	0.013	0.0044
	(0.019)	(0.019)	(0.019)	(0.019)	(0.019)	(0.019)	(0.019)
logTer-Edu $_{t-1}$		-0.0049		-0.016			
		(0.038)		(0.038)			
logNoTer-Edu $_{t-1}$		-0.18***		-0.18***			
		(0.06)		(0.06)			
logTer-Edu Nat $_{t-1}$					-0.054	-0.056	-0.05
					(0.037)	(0.037)	(0.037)
logTer-Edu Migr $_{t-1}$					0.052***	0.050***	0.043***
					(0.01)	(0.01)	(0.01)
logNoTer-Edu Nat $_{t-1}$					-0.30***	-0.29***	-0.29***
					(0.059)	(0.059)	(0.059)
logNoTer-Edu Migr $_{t-1}$					0.04	0.034	0.061**
					(0.026)	(0.026)	(0.027)
logAge			-1.03***	-0.98***		-0.53	
			(0.38)	(0.38)		(0.39)	
logAge, Nat							-0.70*
							(0.36)
logAge, Migr							0.39***
							(0.14)
Observations	144	144	144	144	144	144	144
Number of industry	16	16	16	16	16	16	16
Time dummies	Y	Y	Y	Y	Y	Y	Y
Industry dummies	Y	Y	Y	Y	Y	Y	Y
chi^2	1256	1255	1263	1263	1295	1298	1310
significance	0	0	0	0	0	0	0

Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

5.2 TFP as innovation measure.

The advantages of using TFP growth as a proxy for innovation are many: first of all this measure refers to the effectiveness of the innovation processes in economic terms and, as such, it includes the effects on productivity of any kind of innovation, whether this consists of product or process innovation, investments in codified or tacit knowledge, introduction of radical or incremental innovations.

Second, the data for TFP growth are not limited to the manufacturing sector but, instead, include all sectors of the economy, from agriculture to household services and, as is well known a large set of innovation, takes place in the service sector.

TFP is obtained from the KLEMS dataset which is specified at the NACE two digit sector level for all the sectors in the economy from agriculture to services, in total 31 sectors.

At the same level of aggregation we have derived from the national Labour force survey for the UK, France and from the Microcensus in Germany the information on the human capita described before.

5.2.1 Variables and Trends

The aggregate dynamic of the TFP is increasing less rapidly in the UK, while showing more cycles in France and Germany (see Figure 4.a,b,c). The human capital variables are different from the one presented before because in the previous graphs the data referred only to the manufacturing sector, while now they are related to all the economy. All show an aging of employed workers, an increase in the tertiary educated workers, more pronounced in the UK (from 0.15 to 0.25) than in France (from 0.15 to 0.20) and in Germany (from 0,15 to 0,18). The growth of the young tertiary-educated and of migrants is more pronounced in the UK than in the other two countries.

What, instead, differs a lot is the trend and the growth inside each country between sectors. in the manufacturing and services sectors, and between the high tech and the low tech. Fig.5a,b,c and Fig.6a,b,c and Fig.7a,b,c present for the three countries the trend of the TFP in the high tech sectors[19] which includes Chemicals and chemical products, Machinery and equipment, Electrical and optical equipment, Transport equipment and Coke, refined petroleum products and nuclear fuel activities in the manufacturing and Financial intermediation and Renting of machinery and equipment and other business activities in the services.

While in the UK the increase in foreign employment, the increase in tertiary educated workers seems to match the increase in TFP in both France and Germany a clear link between the two lines is difficult to find.

While in the UK the lead in the TFP is taken by the high tech sector with a TFP always higher than the other sectors, in France and in Germany the lead is taken by the manufacturing sector.

In addition, while in the UK migrants are increasing in all sectors, in France and Germany the share of migrants in manufacturing are declining more than in other sectors (see appendix for summary tables). The complexity of the relationship invites us to still preliminary but more coherent empirical analyses. The endogeneity of migration and in general of human capital variables, which in our analysis is not yet solved, offers the results only as simple correlations which, however, are revealing important features of the long-term relationship.

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[19] The high-tech sectors include the following 2-digit NACE sectors: C23 Coke, refined petroleum products and nuclear fuel - C24 Chemicals and chemical products - C29 Machinery and equipment, n.e.c. - C30T33 Electrical and optical equipment - C34T35 Transport equipment - C65T67 Financial intermediation - C71T74 Renting of machinery and equipment and other business activities.

Figure 4. a. United Kingdom Total Human capital and TFP

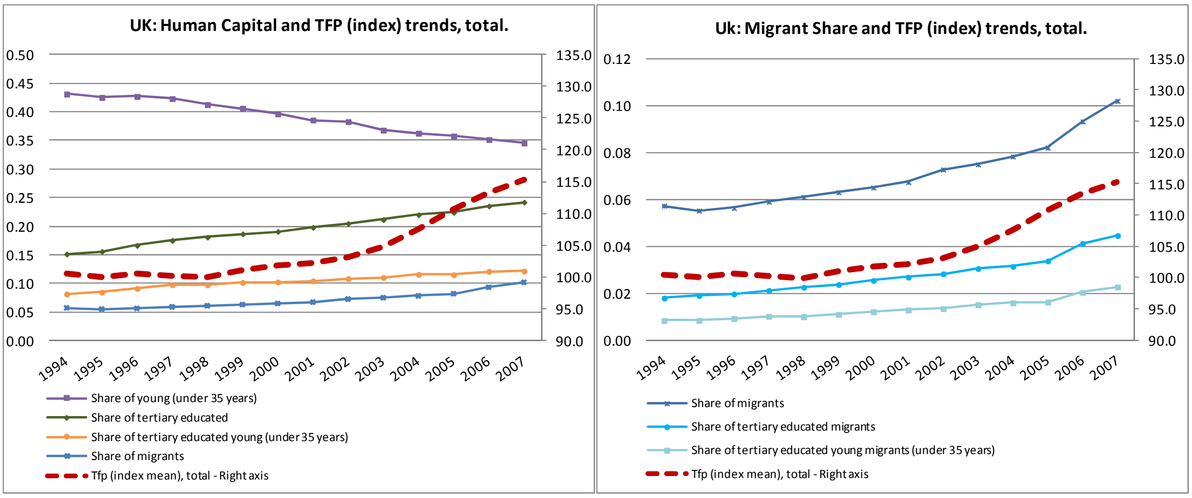


Fig.4.b .France Total Human capital and TFP

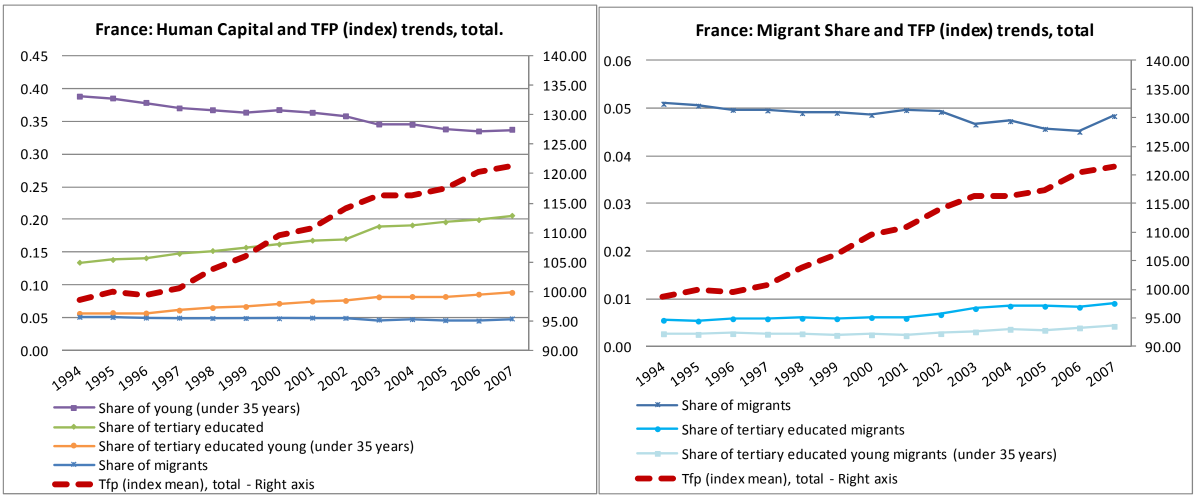


Fig. 4.c. Germany Total Human capital and TFP

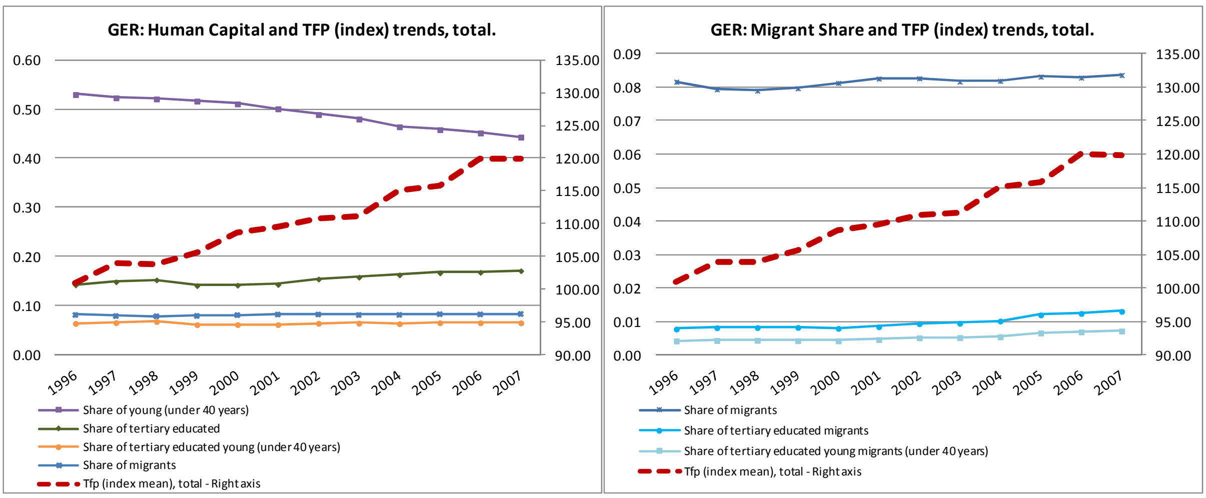


Figure 5.a United Kingdom human capital and TFP in the Manufacturing sector

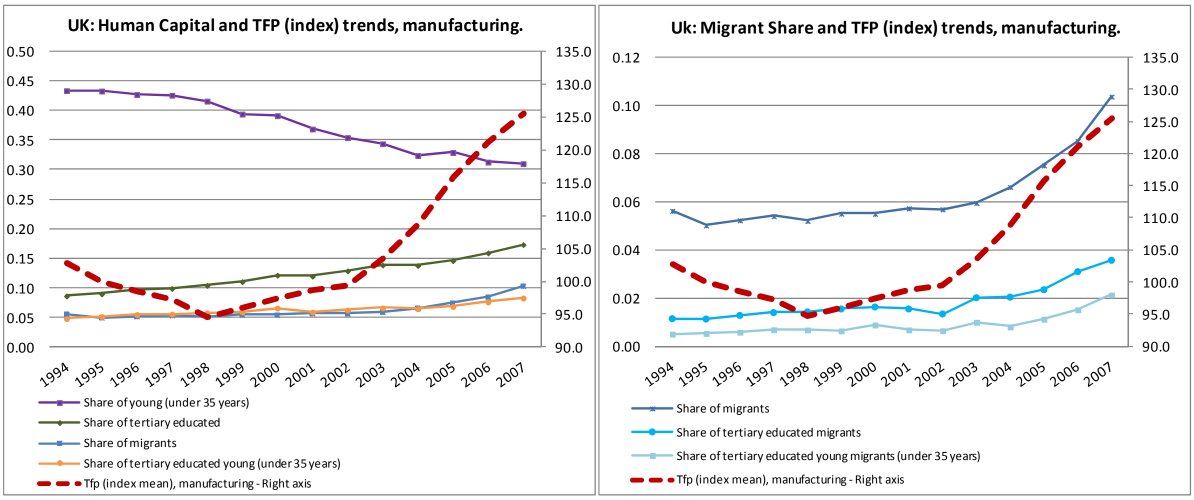


Figure 5.b United Kingdom human capital and TFP in the Service sector

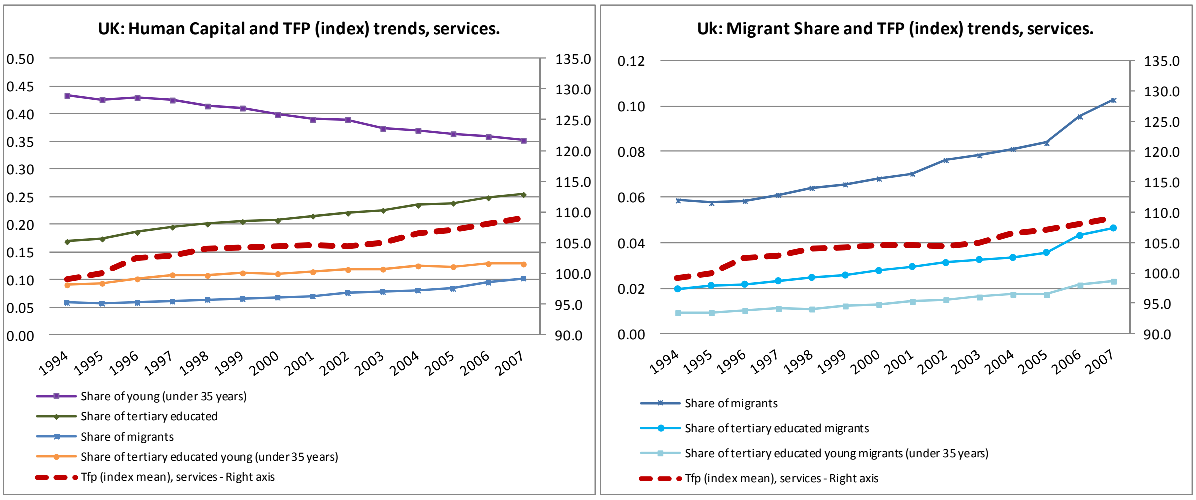


Figure 5.c United Kingdom Human capital and TFP in the High Tech sector

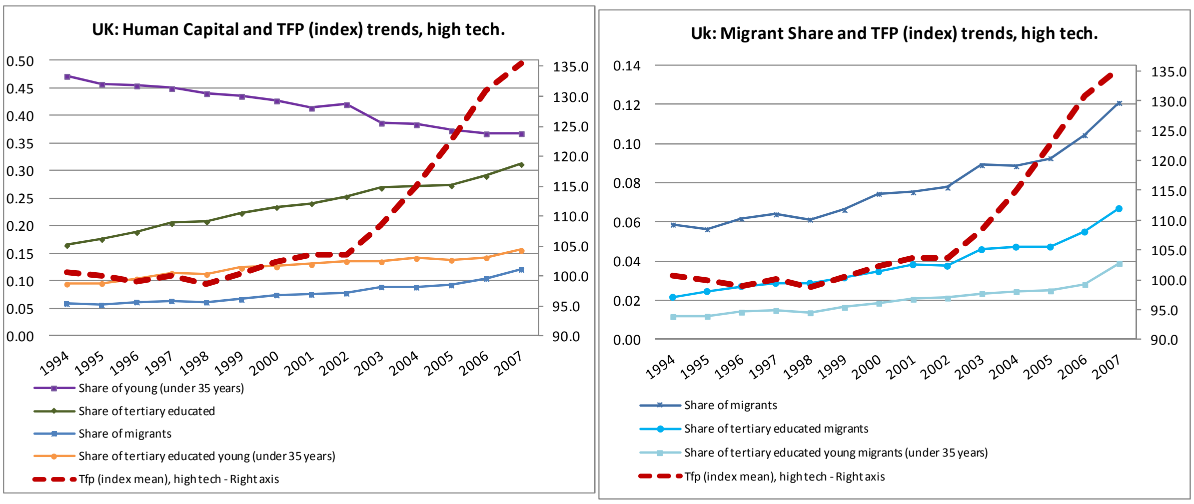


Figure 6.a. France Human capital and TFP in the Manufacturing sector

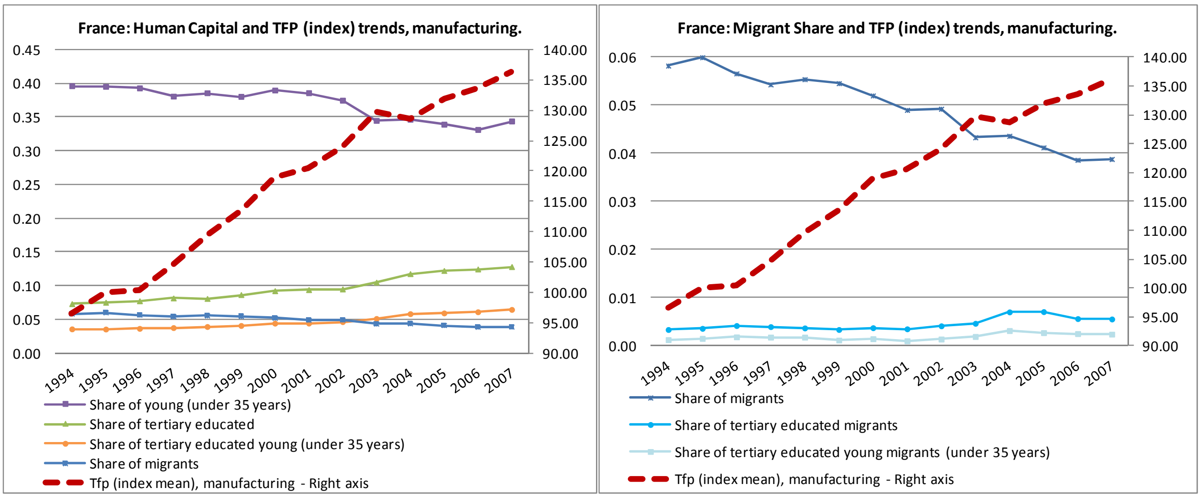


Figure 6.b France Human capital and TFP in the Service sector

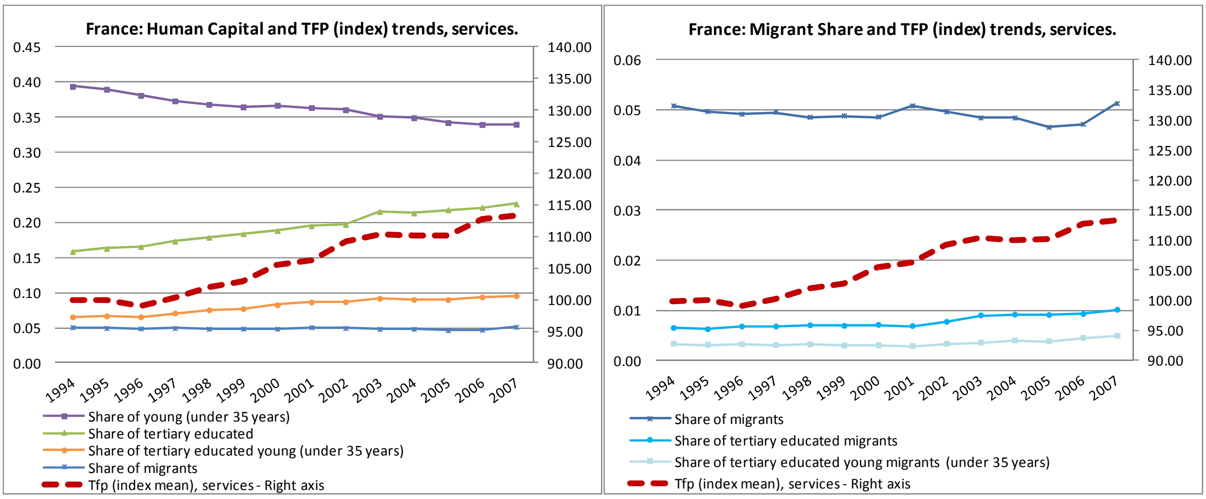


Figure 6.c France Human capital and TFP in the High Tech sector

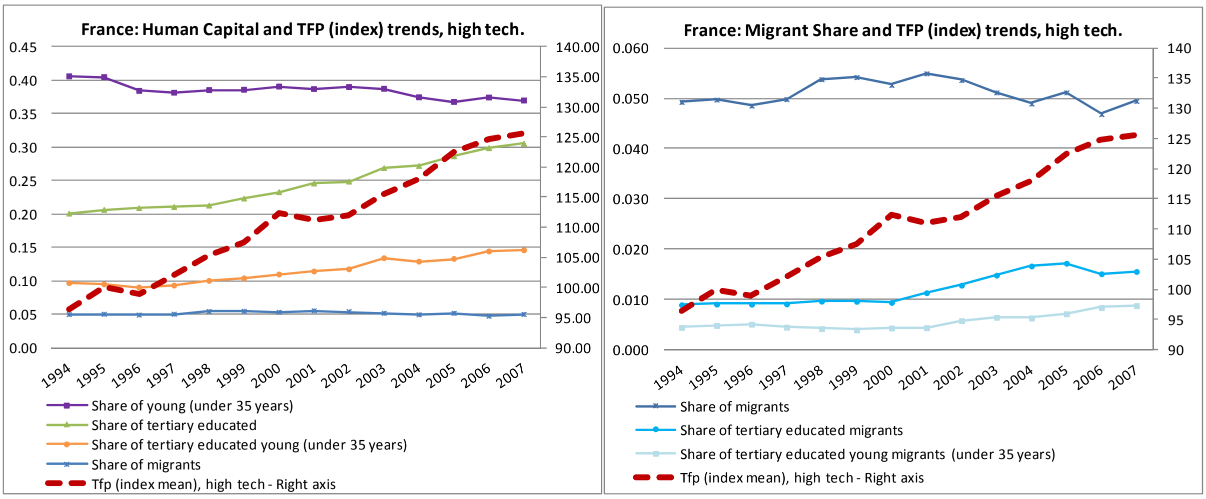
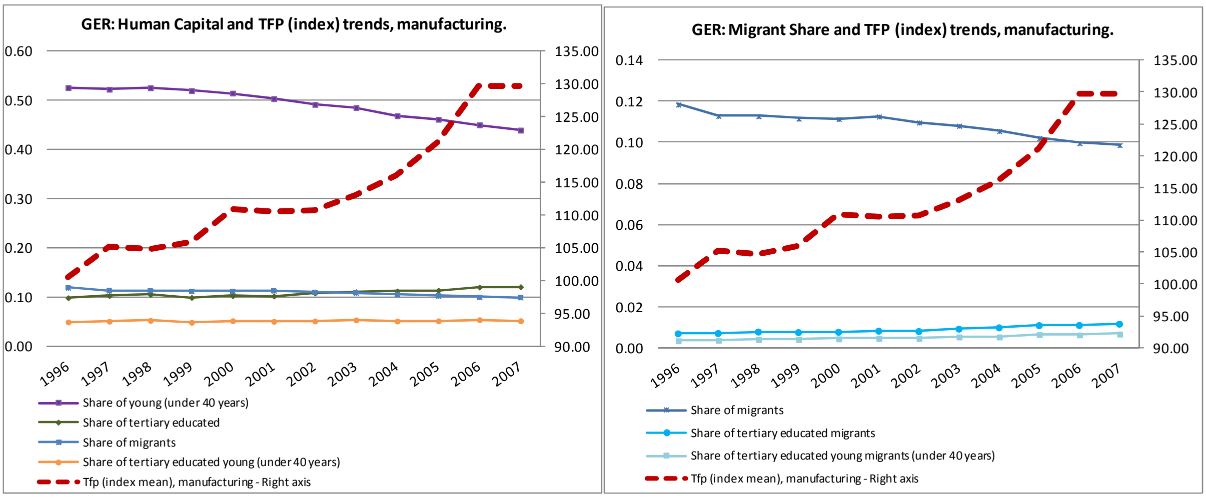


Figure 7.a Germany Human capital and TFP in the manufacturing sector



Fugure 7.b Germany Human capital and TFP in the service sector

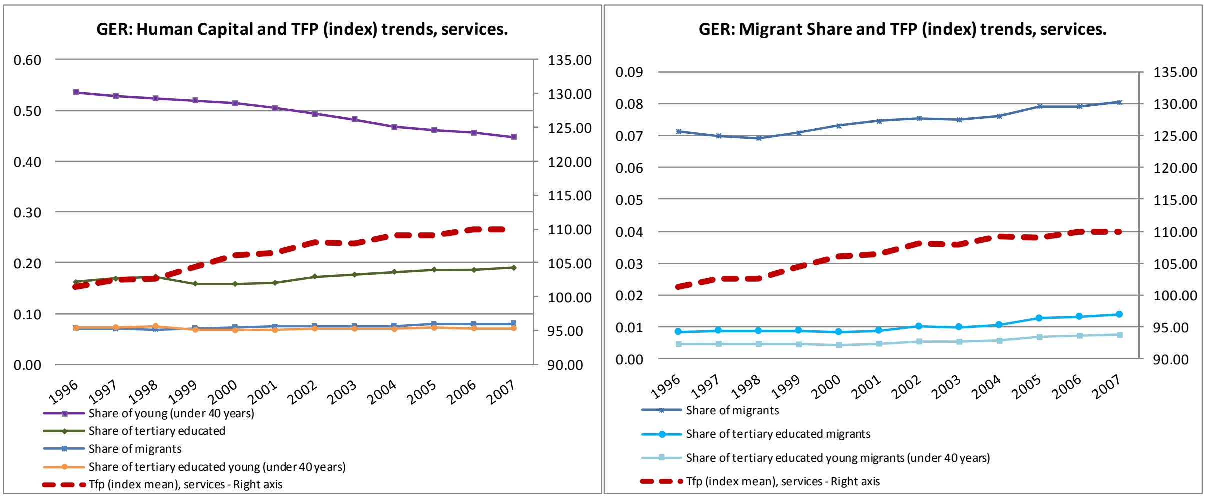
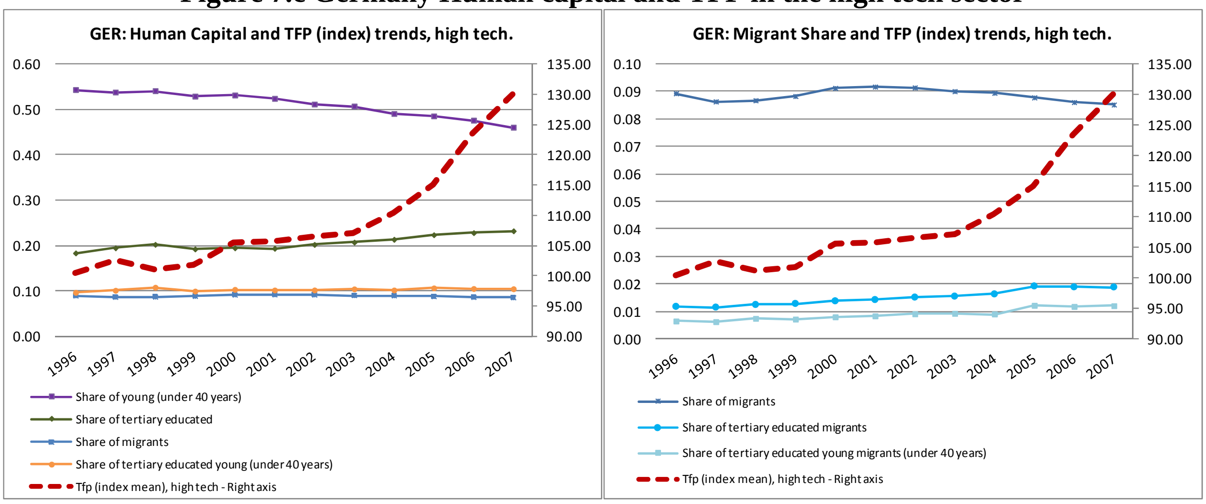


Figure 7.c Germany Human capital and TFP in the high tech sector



As in the patent case we conduct the analyses (OLS) with sector fixed effects and annual time dummies separately for each country. Since the research in this field is less formalized, as discussed in section 4, here we propose some tentative solutions.

In column 1 we inquire if the increase in TFP (Δ TFP) is affected by an increase in migrants (ΔM/E) controlling for the share of migrants (ShMig) in each sector and the share of tertiary educated (ShTerEdu), using the age variable as a proxy for the depreciation or accumulation of human capital.

The results differ in each context. In Germany as in Ortega Peri (2012) migrants growth is negatively correlated with the growth of this innovation proxy, but the share of migrants in total employment and of tertiary educated plays a positive role in favouring innovation.

In France, instead, the share of migrants is significantly negative, while in the UK a different pattern emerges: namely the growth of migrants is positive for the growth of TFP and the age variable suggest an age dividend.

The second specification (column 2) pursues a deeper analysis of the growth of tertiary-educated migrants and natives still controlling for the share of migrants and the share of tertiary educated and distinguishing the role of age among migrants and natives.

In all three countries the growth of tertiary educated migrants fosters innovation, while the growth of educated native apparently reduces it.

In Germany this effect is reinforced by the share of migrants and of the tertiary educated which favours innovation, while among natives age is negatively correlated with TFP growth.

In France among migrants an age dividend prevails, while in the UK a very persistent pattern emerges: an age dividend among the natives and a young dividend among the foreign nationals. Indeed, we see that foreign highly skilled migrants in their first working phase spur innovation.

Similar results emerge in column 3, where the growth of low skilled migrant workers is added and they are in general not significant with the exception of Germany.

In the following specifications (4-5) the share of migrants is replaced by the skill intensity among migrants and natives, calculated as the share of the tertiary educated on, respectively, the total number of migrants and natives in each sector.

This specification is more efficient in Germany, where the share of migrants was already significant and reduces the significance of the migrant tertiary educated growth rate, but not in other cases.

In order to verify, with a different specification, the effect of migration, education and age, the growth of young educated migrants and natives are added in column 6. In all cases the growth of young foreign migrants is positively correlated with innovation and in the French case the growth of young tertiary educated natives .

We also tested additional specifications, not, for the sake of brevity, shown here, which inquire even more into the role of young and old employed (either migrants or natives) in favouring innovation and introduced as controls the share of old migrants and old natives. This specifications reveal a positive effect in the UK exerted by old natives (this is also shown in column 2-5 by the positive coefficient of age among natives), while in France the share of old migrants is positively associated with TFP growth, while such share is negative in the Germany.

Though our OLS estimations control for a great deal of unobserved heterogeneity at the sector level, through the use of fixed effects, and even if there are also robust to the existence of country-level effects that we cancel out with the time-dummies, we still cannot interpret these results as causal relationships, since we cannot control for the problems of endogeneity and reverse causality that typically affect migration flows. Further work is to be done, through the use of appropriate instruments for human capital variables, in order to check for the robustness of these preliminary results..

Table2. Total Factor Productivity and Human Capital, regression results for UK, France, Germany.

	UK						FRANCE						GERMANY					
VARIABLES	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Δ Migrants	0.272*						0.282						-2.453**					
	-0.162						-0.371						-106					
Δ Ter-Edu, migr		0.679***	0.744***	0.796***	0.797***			2.735***	2.509**	3.264***	3.325***			7.523**	7.294**	1.321	1.049	
		-0.248	-0.253	-0.281	-0.282			-1012	-1009	-118	-1187			-3.507	-3.457	-3.559	-3.589	
Δ Ter-Edu, nat		-0.197**			-0.201*			-0.260*			-0.169			-1.852*			-1.214	
		-0.096			-0.102			-0.142			-0.149			-1085			-1035	
Δ Low Skilled, migr			0.098	0.079					-0.097	-0.136					-3.400***	-2.308**		
			-0.184	-0.198					-0.349	-0.337					-1031	-1007		
Δ Ter-Edu young, migr						0.780**						2.725*						9.100**
						-0.373						-154						-4.391
Δ Ter-Edu young, nat						-0.290*						0.513*						-2.182
						-0.167						-0.303						-1452
Share of migrants	-0.294	-0.315	-0.304	-0.257	-0.287	-0.368*	-0.886*	-1.041***	-1.038**	-0.800**	-0.853**	-0.902**	5.538***	3.049***	4.517***	4.515***	3.570***	3.185***
	-0.211	-0.192	-0.206	-0.203	-0.195	-0.194	-0.457	-0.362	-0.405	-0.393	-0.354	-0.374	-1111	-0.98	-1063	-102	-0.943	-0.933
Share of Ter-Edu	0.079	-0.031	0.111				-0.153	0.06	-0.127				3.207***	3.349***	2.548**			
	-0.107	-0.128	-0.106				-0.189	-0.202	-0.177				-1083	-1183	-1025			
Skill intensity, migr				0.012	0.019	-0.004				0.036	0.037	0.064*				1.711***	1.853***	2.007***
				-0.025	-0.023	-0.021				-0.046	-0.045	-0.038				-0.324	-0.324	-0.316
Skill intensity, nat					-0.03	0.024					-0.028	-0.329*					0.838	0.168
					-0.136	-0.125					-0.192	-0.189					-1107	-1034
LogAge, tot	13.801**						-11.703						-96.033					
	-6.553						-18.268						-66.397					
LogAge2, tot	-1.800**						1.589						13.585					
	-0.887						-2.462						-8.977					
LogAge, migr		-3.094**	-3.081**	-3.063**	-3.132**			3.652***	4.018***	-2.262	-1.907			28.967	22.111	12.855	17.002	
		-1217	-1235	-1237	-1219			-131	-1311	-2.425	-2.451			-18.442	-18.291	-17.655	-17.756	
LogAge2, migr		0.425**	0.422**	0.420**	0.431**			-0.483***	-0.532***	0.309	0.262			-4.184	-3.227	-1.915	-2.489	
		-0.166	-0.169	-0.169	-0.167			-0.18	-0.18	-0.326	-0.329			-2.544	-2.523	-2.436	-2.45	
LogAge, nat		11.969**	12.594**	12.165**	11.880**			-17.891	-15.902	-11.997	-13.676			-	-	-78.432	-63.986	
		-5.726	-5.751	-5.749	-5.732			-15.649	-15.702	-15.132	-15.16			-57.971	-57.444	-56.248	-56.506	
LogAge2, nat		-1.555**	-1.634**	-1.576**	-1.543**			2.412	2.148	1.617	1.841			16.257**	19.004**	11.177	9.213	
		-0.774	-0.777	-0.777	-0.775			-2.11	-2.117	-2.04	-2.044			-7.831	-7.76	-7.597	-7.632	
Constant	-26.407**	-17.326	-18.603*	-17.840*	-17.111	0.042	21.619	26.326	21.891	26.401	28.893	0.111***	168.368	157.114	206.154*	115.074	80.984	-0.573***
	-12.105	-10.713	-10.755	-10.751	-10.728	-0.028	-33.899	-28.992	-29.069	-27.98	-28.024	-0.033	-122.785	-106.944	-106.423	-103.769	-103.607	-0.164
Obs.	390	390	390	390	390	390	372	367	367	363	363	367	310	310	310	310	310	310
R-squared	0.143	0.182	0.173	0.171	0.184	0.117	0.047	0.136	0.127	0.115	0.119	0.094	0.185	0.272	0.294	0.347	0.337	0.256

Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

5.2.2 High tech component

Given the different trends in total factor productivity and in the share of migrants in the different sectors we expected that the aggregate results reported before might be conditioned by the aggregation at national level of each sector effect.

Figure 8. TFP and Share of migrants by sector and country

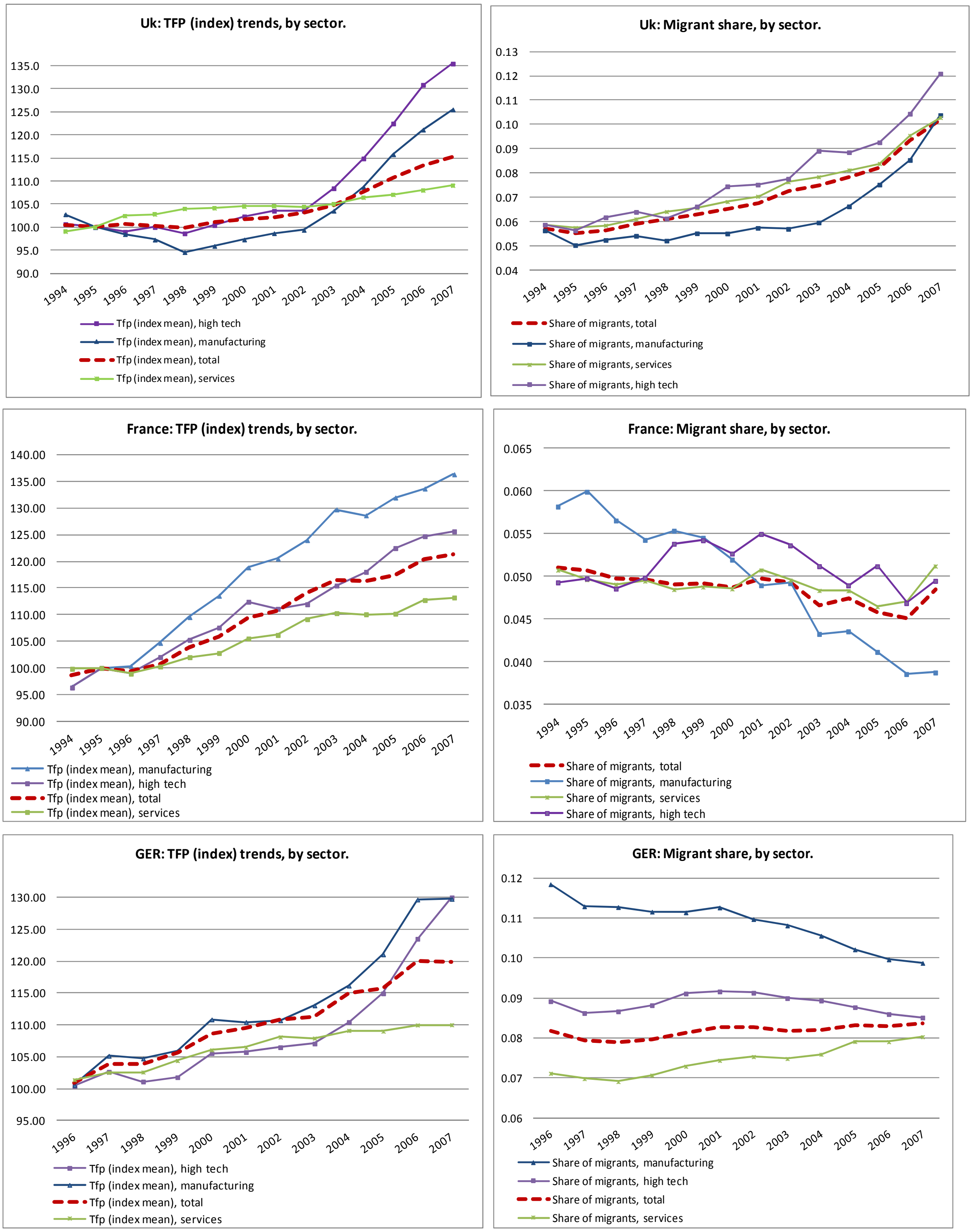


Figure 8, however, suggests that the country effect dominates over the sector effect. The dynamics of TFP and of the share of migrants in each sector are more similar inside the country than among sectors as Figure 8 points out. In the UK the share of migrants is increasing in the sectors, also in the reluctant service sector, in France and Germany instead only the manufacturing sector shows a rapid decline. But neither in Germany nor in France has the high tech sector registered a growth in the share of migrants.

Thus to better inquire into the specific role played by the Human capital variables in the High Tech productions, we have interacted the specifications of column 2 and 3 of Table 3 with a High Tech-dummy.

In the UK the introduction of this interacted dummy on the growth of highly-educated migrants does not change the aggregate picture, the young dividend among the migrants and the old age dividend remains stable as table 4 shows.

If we calculate the specific effect in the two sectors: high tech and manufacturing the coefficients are the same in both sectors, while the growth of natives, highly skilled or of migrants low skilled is not significant[20].

In France the introduction of the interacted dummy for the High Tech sector shows that the positive effect of the growth of educated migrants on the growth of TFP is not significantly different in the high tech sectors with respect to the other sectors: indeed the interacted coefficient is not significant.

In Germany the interacted dummy with the growth of highly educated in the high tech sector shows a very large positive role of highly-skilled migrants and a negative one for the low skilled in the high tech sector[21].

Summing up education matters for innovation, in particular the education of migrants. Its growth pushes in all countries and in all specification the growth of TFP. The growth of low skilled migrants in this preliminary analysis is not significant in the UK and in France, while it is negative and significant in Germany and this result is stable in many different specifications. The growth of educated natives - probably because it affects a lot the service sector which has a lower productivity growth - is not significant or it is negative, as in Germany, and this negative sign is persistent in many specifications. However, its coefficient is frequently not significant, especially when the variables concerning the skill intensity of migrants is adopted.

[20] Not reported, available on demand.

[21] If we run separate regression for each sector the growth of highly-skilled migrants lose significance in favour of the skill intensity of migrants which is, however, strongly and positively significant in both sectors. The age dividend remains the same showing a young dividend for natives in all sectors and an old dividend of migrants in the manufacturing sector.

Table3. Total Factor Productivity and Human Capital, regression results for UK, France, Germany (2).

	UK		France		Germany	
	(1)	(2)	(1)	(2)	(1)	(2)
VARIABLES	logTFP, t-1	logTFP, t-1	logTFP, t-1	logTFP, t-1	logTFP, t-1	logTFP, t-1
Δ Ter-Edu, migr	0.381	0.46	4.438***	4.273***	-4.795	-4.482
	-0.314	-0.322	-1.197	-1.198	-4.847	-4.626
Δ Ter-Edu high tech, migr	0.721	0.755	-4.237	-3.496	23.597***	24.701***
	-0.487	-0.497	-2.613	-2.468	-6.576	-6.318
Δ Ter-Edu, nat	-0.12		-0.255		-1.249	
	-0.136		-0.168		-1.362	
Δ Ter-Edu High Tech, nat	-0.122		0.325		-0.578	
	-0.163		-0.273		-1.829	
Δ Low skilled, migr		0.113		-0.209		-1.684
		-0.213		-0.342		-1.03
Δ Low skilled High Tech, migr		-0.19		0.24		-14.878***
		-0.396		-1.257		-3.434
Share of migrants, t-1	-0.247	-0.25	-0.905**	-0.811**	2.821***	3.503***
	-0.197	-0.209	-0.353	-0.395	-0.964	-1.025
Share of Ter-Edu, t-1	-0.05	0.086	0.028	-0.079	3.177***	2.553***
	-0.128	-0.107	-0.198	-0.182	-1.161	-0.972
LogAge, migr	-2.930**	-3.004**	-1.652	-1.598	29.18	23.807
	-1.221	-1.241	-2.563	-2.576	-18.067	-17.352
LogAge2, migr	0.402**	0.411**	0.227	0.219	-4.222*	-3.461
	-0.167	-0.17	-0.345	-0.347	-2.492	-2.393
LogAge, nat	12.231**	12.674**	-14.305	-11.649	-135.986**	-137.465**
	-5.729	-5.75	-15.203	-15.202	-57.201	-54.828
LogAge2, nat	-1.591**	-1.647**	1.928	1.57	18.850**	19.039**
	-0.774	-0.777	-2.05	-2.05	-7.726	-7.406
Constant	-18.100*	-18.863*	29.587	24.584	194.141*	206.516**
	-10.73	-10.75	-28.08	-28.075	-105.54	-101.567
Obs.	390	390	360	360	310	310
	0.188	0.178	0.114	0.107	0.307	0.369
Number of industry	30	30	30	30	31	31

Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

The interacted dummy with the growth of highly-educated migrants in the high tech sector, instead, is always significant with the expected sign in Germany, but not in the UK and France, supporting the view that highly-skilled migrants do not spur innovation and TFP growth only in the high-tech sectors.

An unexpected age dividend is revealed among natives in the UK and among migrants in France, while a young dividend is found among the foreign nationals in the UK and among natives in Germany.

The growth of young educated migrants is spurring growth in all three countries, and we could conclude that the use of the skill intensity variable (namely the share of tertiary educated migrants against the total number of migrants in each sector is the same for natives) strongly controls for high and low tech differential effect. The skill intensity variable is significant in Germany, where a difference between High and low tech exists, which is not significant in the UK and France where the difference disappears.

Before moving to a final conclusion we would like to offer two reflections.

The analysis developed under report the strong complementarity in innovation between sectors, and it has limited the analysis to the role of human resources – highly-skilled and low-skilled foreign nationals and natives – inside a sector, disregarding the very strong complementarity between sectors. Low-skilled workers in the agriculture sector or in the household sector favour the labour force participation of the highly skilled in other sectors and spur innovation. A different way of testing the spillover of human capital in innovation should be used and in further analyses we will try to proceed in this direction.

More specifically the debate on the role of human capital in development points out the presence of significant brain waste among both natives and migrants. The use of the variables for tertiary educated natives and migrants as proxy for the highly-skilled disregard this issue. However, the non-significant effect of the increase in tertiary educated employment of natives and migrants could be imputed to the poor quality of education and thus poor human capital and the over education of the labour force.

We have tried to dig more into this issue by replacing the variable growth of tertiary-educated migrants and natives by high occupation for the UK the country where our dataset is more detailed.

The interesting result is that the growth of managers and administrators (ISCO1) always play a negative role, while professional occupations and associate professional and technical occupations (ISCO2 and 3) play a positive role. These results, however, do not answer simply the question presented above, namely are highly-educated workers in highly-skilled jobs more efficient in spurring innovation and productivity? Rather they enter more into the organizational issues of production, namely if only the workers directly involved in production and a slim organization favour innovation. This though lies outside the scope of this research.

6. Concluding comments

Europe is facing a serious down turn, the unemployment rate is increasing and the need to increase competitiveness is at the top of the agenda of each member state.

If an increase in the unemployment rate of the natives push for a more restrictive immigration policy, the search for competitiveness spurs innovation and in this research we have shown the fundamental role played by migrants in innovating in the three largest European countries.

These three countries are particularly interesting for their differences. They differ in their age pyramid, in France the young (below 15 years old) are 1.35 of the retired (more than 65 years old), while in Germany and the UK the size of the young is smaller than the size of the older (respectively 0.85 and 0.89).It is not though only the population which is different, but also production. In Germany the manufacturing sector still dominates, while in the UK services dominates while in France the agricultural sector still produces 2.5% of GNP. All of them are old immigration countries in which migrants are between 11 and 8% of the population. But they have different migration policies: the UK encourages highly-skilled migration both within the educational system and through migration policy, while neither France or Germany succeed in doing this and only with the recent revision in 2005 has Germany fully accepted the idea of permanent immigration status.

Innovation is, in addition, a very complex phenomenon, multi-faceted and thus difficult to define and to measure.

We have chosen the two most popular indicators of innovation: the number of patent applications at the European Patenting Office which provides information on the technological activities of inventors and companies and the Total Factor Productivity growth which is a measure of technical progress in the broadest sense.

The two measures point out different dimensions of the innovation phenomenon: the TFP is a proxy of the contingent effectiveness of innovation adopted now in production, while the number of Patents registered each year is a proxy of the potential and future capacity of innovation.

Research on the effects of migration and these two measure of innovation is very limited. In general research on the impact of human resources is more developed at establishment level and does not provide aggregate insight.

Given the limited and contradictory results of previous research where Ortega Peri (2011) found at national level negative or no effect for the growth of migrants on the TFP, and Nijkan et. (2011) at regional European level found there was no effect for the number of migrants on the patents registered but a positive effect for its variety index, we decided to move toward an analyses of the role played by migrants at sector level which was the direction taken by a previous although very broad report of the European Competitiveness report (2009).

However, conditioned by data disaggregation we limited our analysis to the three largest European countries France, Germany and the UK in the period 1994-2007.

Unfortunately we were unable to control for the changes induced by the recession in the role of foreign labour, but this limitation is not particularly relevant given that the present downturn is a global phenomenon with macro causes not correlated with migration policy.

The different measures of innovation do not overlap strictly thus also the results presents some differences.

What emerges is, however, that highly-educated workers favour future innovation measured as the number of patent applicants. However, the impact of the native and foreign highly skilled is not always the same: the native highly skilled in France and highly-skilled migrants in the UK and Germany favour long term innovation capacity. However, not only the highly skilled but also the low skilled play a positive role in France and in Germany, while in the UK low skilled natives spur innovation.

In addition the contribution to innovation is not only in the hands of young workers. Of course, there is a young dividend for all groups in France, but in the UK the natives accumulate human capital and become more innovative creators in their old age (Old Dividend), while young migrants innovate more in their young age. The reverse happens in Germany, old aged migrants and low-skilled and highly-skilled migrants favour long-term innovation, while natives favour innovation when they are young.

Also in the short run highly-skilled migrants favour innovation measured as Total Factor Productivity, in particular young tertiary educated migrants spur innovation in all three countries.

But the growth of the low skilled is not reducing proactive innovation in the UK and France and while they play a negative role in Germany.

Again both an old and young dividend is found in the UK – where the natives hold an age dividend and foreign nationals a young one –and in Germany – where old migrants contribute to short run innovation and young natives. In France a young dividend remains among the natives and foreign nationals seem to be more productive in their old age.

The dataset on TFP covers 31 sectors including services and agriculture, thus we have explored the possibility of different coefficients for the high tech sector. Only in Germany the high tech sector seems to catalyze the positive role for migrants, while in the UK and France no significant differential role emerges, either for the High and low skilled migrants or for the highly educated natives.

This preliminary empirical analysis suggests that to pursue the objectives of the Europe 2020 strategy which encourages the competitiveness of the European economy migration policy is as crucial as foreign workers.

The results presented are preliminary but consistent in many specifications. The positive effects of highly-skilled workers both native and foreign is, however, limited inside each sector, thus it underestimates the total positive effect of human capital changes because the complementarity between sectors and the positive spillover are not taken into account and it is well known that innovation has a strong systemic effect.

Appendix 1

Table 4. Variables used for Patent regressions, UK 1994-2007.

	Industry	Avg Number of Patent	Stock Patent	R&D	OT	K	Avg age, tot	Avg age, nat	Avg age, migr	Avg age highly sk., tot	Avg age highly sk., nat	Avg age highly sk., migr	E, tot	E, nat	E, migr	E highly sk, tot	E highly sk., nat	E highly sk., migr
15-16	Food, bev. & tobacco	59.03	6.27	19.888	1.224	21.549	39.47	39.75	37.73	33.05	32.81	34.76	15193	14030	1163	1467	1208	259
		13.20	0.05	0.109	0.145	0.123	105	140	145	155	160	2.79						
17-19	Textile, leather & footwear	28.56	5.28	17.495	3.800	19.634	41.29	41.37	40.74	36.71	35.70	39.72	10193	8971	1222	705	516	189
		5.74	0.22	0.309	1323	0.569	2.04	2.20	183	2.26	2.68	2.52						
20	Wood, of wood & cork	8.54	3.96	.	1.255	19.031	39.18	39.18	40.04	36.23	36.35	34.33	2809	2720	89	156	138	18
		4.07	0.34	.	0.200	0.201	1.18	135	6.32	3.44	3.80	5.86						
21-22	Pulp, paper, print. & publishing	32.43	5.57	.	1.781	20.010	40.90	41.09	38.88	37.95	38.15	38.13	3574	3388	186	282	237	45
		6.32	0.12	.	0.110	0.399	137	158	4.22	3.52	3.63	7.64						
24	Chemicals & chemical	1213.79	9.18	22.499	3.211	21.769	40.10	40.21	38.77	36.52	36.45	37.36	9539	8973	566	2325	2037	288
		166.98	0.14	0.118	0.409	0.163	104	1.12	2.13	0.99	107	2.55						
25	Rubber & plastics	208.53	7.92	18.540	1.340	20.454	39.50	39.49	40.02	36.55	36.09	39.41	7763	7384	379	510	437	73
		29.20	0.10	0.170	0.262	0.326	158	168	2.73	3.39	3.90	5.36						
26	Other non-metallic mineral	85.37	6.82	18.325	0.823	20.215	40.85	40.86	42.01	37.96	37.44	43.95	4985	4799	186	398	348	50
		11.95	0.03	0.185	0.072	0.155	1.19	132	4.05	2.00	2.31	9.04						
27	Basic metals	50.52	6.22	18.291	4.875	19.968	42.09	42.01	44.13	39.64	38.67	45.47	4619	4413	206	324	272	52
		9.10	0.03	0.311	1397	0.253	152	158	2.82	3.77	4.34	7.58						
28	Fabricated metal products	144.56	7.13	18.741	0.686	20.586	41.71	41.68	42.86	38.67	38.15	42.62	12603	12086	517	794	687	107
		27.20	0.10	0.201	0.114	0.183	139	153	2.39	2.35	2.79	3.92						
29	Machinery & equip.	749.82	8.89	20.937	2.589	20.695	41.51	41.64	40.63	37.49	37.52	38.42	14052	13347	705	1430	1237	193
		79.17	0.02	0.094	0.309	0.262	135	158	2.81	129	162	3.96						
30	Office, account. & comput. apparatus	492.19	8.10	18.882	14.135	18.987	37.68	37.76	37.03	36.34	36.48	35.45	3548	3273	275	994	836	158
		143.73	0.28	0.541	3.109	0.782	2.05	2.20	184	189	2.17	2.27						
31	Electrical machinery & apparatus	140.74	7.10	20.433	2.934	19.886	40.11	40.09	40.68	38.05	37.65	40.94	6887	6497	390	834	714	120
		21.45	0.09	0.203	0.587	0.398	120	127	187	158	163	3.70						
32	Radio, TV & communication	712.45	8.50	21.016	6.802	20.156	38.36	38.31	39.08	36.62	36.64	36.82	4236	3944	292	727	610	117
		147.61	0.24	0.187	0.910	0.973	150	161	2.53	184	2.26	3.15						
33	Medical, precision & optical instruments	756.30	8.81	20.411	2.539	19.835	41.10	41.07	41.67	38.86	38.84	38.22	4364	4121	243	774	689	85
		160.55	0.09	0.179	0.435	0.139	152	163	2.87	167	174	4.03						
34	Motor vehicles, trailers & semi-trailers	207.54	7.56	21.127	5.131	21.262	40.48	40.41	41.80	36.31	35.78	38.70	9169	8524	645	766	634	132
		27.33	0.06	0.154	0.942	0.270	0.81	0.95	194	133	182	3.78						
35	Other transport equip.	69.92	6.20	21.625	3.102	20.469	41.66	41.68	41.25	37.95	38.06	37.01	7560	7253	307	950	855	95
		25.96	0.20	0.255	0.551	0.576	121	124	188	131	142	4.57						
36	Manufacturing, n.e.c.	94.20	6.60	17.690	.	19.930	39.36	39.37	39.49	36.73	36.29	39.10	7103	6713	390	606	507	99
		17.17	0.15	0.299	.	0.152	145	154	2.17	194	2.18	2.73						
	Total, avg and sum values	297.32	7.07	19.727	3.514	20.267	40.32	40.35	40.40	37.15	36.89	38.85	128197	120436	7761	14042	11962	2080
		353.03	139	1519	3.353	0.855	183	192	3.35	2.64	2.87	5.38						

Table 5. Variables used for Patent regressions, mean and standard error values, France 1994-2007.

	Industry	Avg Number of Patent	Stock Patent	R&D	OT	K	Avg age, tot	Avg age, nat	Avg age, migr	Avg age highly sk., tot	Avg age highly sk., nat	Avg age highly sk., migr	E, tot	E, nat	E, migr	E highly sk, tot	E highly sk., nat	E highly sk., migr
15-16	Food, bev. & tobacco	68.41	6.21	19.929	1.823	22.266	37.97	37.88	40.63	35.23	35.18	38.22	37027	35827	1200	2182	2089	93
		18.40	0.18	0.177	0.201	0.114	0.68	0.71	1.04	0.82	0.85	6.04						
17-19	Textile, leather & footwear	58.85	5.96	18.753	4.050	20.329	41.44	41.47	41.33	37.42	37.32	38.79	13656	12323	1333	775	718	57
		8.95	0.24	0.168	1.045	0.299	1.56	1.57	2.47	1.76	1.78	6.43						
20	Wood, of wood & cork	12.05	4.37	16.555	1.111	20.125	38.81	38.64	41.89	38.36	38.23	44.67	6066	5750	316	258	253	5
		6.08	0.20	0.277	0.181	0.166	0.86	0.80	3.30	1.45	1.63	7.23						
21-22	Pulp, paper, print. & publishing	30.75	5.43	17.933	2.524	20.650	39.97	39.91	41.20	38.05	37.91	41.75	5431	5261	170	436	428	8
		6.15	0.18	0.130	0.453	0.159	1.56	1.55	4.47	2.08	2.03	12.77						
24	Chemicals & chemical	1356.44	9.14	22.206	4.237	21.644	40.03	39.97	41.52	38.02	38.01	38.47	16220	15704	516	3385	3254	131
		160.80	0.22	0.111	0.480	0.195	0.46	0.47	1.90	0.53	0.55	4.05						
25	Rubber & plastics	365.48	7.97	20.304	1.666	21.262	39.08	38.93	41.52	37.78	37.76	39.05	13921	13105	816	1191	1126	65
		48.76	0.13	0.250	0.112	0.089	0.78	0.80	2.12	1.45	1.42	7.88						
26	Other non-metallic mineral	161.83	7.12	19.423	1.013	21.274	40.98	40.79	44.94	38.90	38.89	38.02	9147	8691	456	605	579	26
		23.59	0.14	0.097	0.136	0.191	0.68	0.64	3.92	1.76	1.90	6.23						
27	Basic metals	109.56	6.98	19.605	4.333	20.851	41.60	41.28	45.38	39.37	39.38	38.95	8078	7470	608	600	580	20
		15.18	0.02	0.095	1.938	0.196	0.81	0.94	2.76	1.29	1.39	6.13						
28	Fabricated metal products	230.92	7.51	19.255	0.675	21.579	39.67	39.42	42.99	37.61	37.61	38.33	26849	25101	1748	1217	1160	57
		43.66	0.13	0.128	0.124	0.111	0.99	1.06	1.50	1.11	1.16	6.89						
29	Machinery & equip.	1133.55	9.11	20.819	2.946	21.109	40.14	40.07	41.86	37.65	37.40	42.53	18913	18215	698	1684	1590	94
		151.29	0.12	0.097	0.271	0.166	0.48	0.48	1.09	1.30	1.33	3.66						
30	Office, account. & comput. apparatus	522.54	8.09	19.625	29.336	20.786	39.77	39.87	36.94	38.94	39.08	37.35	1612	1543	69	597	551	46
		136.50	0.31	0.460	26.930	0.330	1.36	1.37	5.32	1.67	1.60	7.16						
31	Electrical machinery & apparatus	343.85	7.98	20.554	3.142	20.457	40.17	40.05	43.43	38.02	37.96	39.36	9651	9292	359	1013	966	47
		31.53	0.08	0.130	0.777	0.413	0.94	0.95	2.67	1.59	1.53	5.71						
32	Radio, TV & communication	984.23	8.70	21.746	4.879	21.145	39.02	39.00	39.43	36.86	36.61	40.10	6967	6752	215	1529	1437	92
		255.13	0.32	0.115	2.070	0.432	1.04	1.00	4.28	1.14	1.11	3.79						
33	Medical, precision & optical instruments	759.97	8.60	21.263	2.341	20.877	39.62	39.62	39.57	38.05	38.04	38.15	8093	7797	296	1377	1324	53
		148.16	0.18	0.150	0.337	0.191	0.89	0.87	3.50	1.21	1.32	5.33						
34	Motor vehicles, trailers & semi-trailers	599.38	8.18	21.877	5.319	22.105	40.26	39.97	43.70	37.09	37.24	35.34	20743	19413	1330	1800	1684	116
		177.86	0.31	0.166	0.919	0.170	0.44	0.52	3.30	1.25	1.30	4.84						
35	Other transport equip.	149.08	6.87	21.757	4.263	20.996	40.50	40.43	42.09	38.47	38.46	38.86	7493	7282	211	1470	1409	61
		60.74	0.22	0.082	1.389	0.199	1.59	1.63	2.63	2.58	2.56	5.98						
36	Manufacturing, n.e.c.	135.54	7.06	18.975	.	20.087	39.55	39.44	41.92	37.07	37.06	36.55	9787	9374	413	639	602	37
		10.46	0.08	0.341	.	0.198	0.80	0.79	2.74	1.28	1.29	5.38						
	Total, avg and sum values	413.08	7.37	20.034	4.604	21.030	39.92	39.81	41.78	37.82	37.77	38.70	219654	208900	10754	20758	19750	1008
		419.43	1.30	1.493	9.274	0.670	1.32	1.32	3.60	1.72	1.76	6.11						

Table 6. Variables used for Patent regressions, mean and standard error values, Germany 1996-2007.

	Industry	Avg Number of Patent	Stock Patent	R&D	OT	K	Avg age, tot	Avg age, nat	Avg age, migr	Avg age highly sk., tot	Avg age highly sk., nat	Avg age highly sk., migr	E, tot	E, nat	E, migr	E highly sk, tot	E highly sk., nat	E highly sk., migr
15-16	Food, bev. & tobacco	127.81	7.06	19.517	1.576	22.388	39.23	39.58	36.37	39.85	41.44	38.50	10500000	9414292	1132404	421544	382969	38575
		31.29	0.05	0.160	0.322	0.039	0.44	0.38	1.04	1.31	0.94	1.79						
17-19	Textile, leather & footwe	99.94	6.74	19.288	6.249	20.603	41.86	42.11	40.32	40.27	41.93	37.19	3859232	3326672	532560	226270	197076	29194
		16.55	0.08	0.124	0.777	0.193	0.65	0.55	1.62	3.80	0.78	1.37						
20	Wood, of wood & cork	52.57	6.15	17.126	1.120	20.590	39.26	39.27	39.12	42.18	42.78	36.35	2531247	2316627	214620	91876	81815	10061
		11.22	0.05	0.203	0.267	0.298	1.17	1.19	1.90	1.90	1.87	2.18						
21-22	Pulp, paper, print. & publishing	103.02	6.58	18.330	2.555	21.330	40.58	40.81	39.27	42.26	42.89	36.25	1811014	1537561	273453	120504	108118	12386
		19.55	0.17	0.304	0.370	0.186	0.63	0.59	1.06	2.31	2.69	4.38						
24	Chemicals & chemical	3600.62	10.26	22.680	3.132	22.689	40.57	40.69	39.24	41.95	42.17	39.52	7653372	7024296	629076	1332873	1231460	101413
		315.64	0.11	0.073	0.562	0.083	0.55	0.55	0.69	0.56	0.63	1.97						
25	Rubber & plastics	793.37	8.68	20.419	1.675	21.735	39.74	39.97	38.46	41.61	41.95	37.79	3988451	3399439	589012	273503	247221	26282
		78.70	0.14	0.174	0.249	0.089	0.55	0.47	1.45	1.30	1.28	3.28						
26	Other non-metallic mineral	502.44	8.24	19.656	0.974	21.507	40.91	41.08	39.53	43.55	43.78	40.59	3015835	2685494	330342	216084	199783	16301
		56.28	0.13	0.126	0.135	0.211	0.82	0.82	1.36	1.42	1.50	3.54						
27	Basic metals	301.72	7.82	19.680	3.653	21.726	40.64	40.87	39.43	43.50	43.84	38.92	4022672	3408950	613723	232289	215634	16655
		22.61	0.09	0.154	1.460	0.141	0.84	0.72	1.60	0.95	1.04	2.85						
28	Fabricated metal products	905.54	8.69	20.208	0.862	22.183	39.88	40.04	38.73	42.90	43.17	40.03	12200000	10700000	1438593	617182	571572	45610
		111.76	0.20	0.111	0.144	0.142	0.48	0.43	1.07	1.10	1.29	2.46						
29	Machinery & equip.	4909.12	10.41	22.201	2.176	22.473	40.31	40.34	40.03	42.22	42.33	40.80	14300000	13000000	1272939	1942809	1827634	115175
		771.01	0.19	0.106	0.427	0.143	0.44	0.38	1.32	0.66	0.76	2.15						
30	Office, account. & comput. apparatus	1076.17	8.76	20.394	10.869	19.921	38.30	38.48	36.51	40.20	40.23	40.09	1255564	1141422	114142	356938	323163	33775
		229.80	0.31	0.154	8.630	0.377	0.74	0.76	1.63	1.34	1.38	2.89						
31	Electrical machinery & apparatus	1127.22	8.98	20.999	1.819	21.862	39.95	40.02	39.30	41.80	41.96	39.98	4880246	4382982	497264	878379	805265	73114
		98.78	0.16	0.126	0.351	0.115	0.77	0.74	1.26	0.81	0.91	1.09						
32	Radio, TV & communication	2140.82	9.50	22.107	4.725	21.561	38.98	39.15	37.35	40.45	40.64	38.90	3175819	2863272	312547	730810	661007	69803
		300.02	0.26	0.081	1.517	0.310	0.60	0.70	0.89	0.67	0.90	2.59						
33	Medical, precision & optical instruments	2563.84	9.70	21.675	2.461	21.041	39.59	39.72	38.00	41.20	41.39	39.17	3611216	3337508	273708	530261	488234	42027
		459.16	0.23	0.255	0.398	0.170	0.83	0.81	1.18	0.72	0.68	2.50						
34	Motor vehicles, trailers & semi-trailers	2345.07	9.54	23.210	3.138	23.141	38.97	39.01	38.78	39.22	39.38	37.59	11300000	9534735	1748295	1445606	1314477	131129
		322.35	0.29	0.225	0.460	0.146	0.58	0.64	0.59	0.53	0.54	2.09						
35	Other transport equip.	257.21	7.59	21.759	5.277	20.807	40.07	40.15	39.31	42.24	42.41	41.17	2207243	1984681	222562	390194	343343	46851
		45.32	0.11	0.141	0.740	0.195	0.48	0.46	1.13	0.69	0.71	2.71						
36	Manufacturing, n.e.c.	315.34	7.76	19.057	.	20.774	39.14	39.24	38.03	41.21	41.46	38.55	4509370	4164472	344898	224679	204015	20664
		39.76	0.13	0.097	.	0.178	0.93	0.95	1.05	1.08	1.08	2.58						
	Total, avg and sum values	1248.34	8.38	20.489	3.266	21.549	39.88	40.03	38.69	41.56	41.98	38.91	94800000	84300000	10500000	10000000	9202786	829011
		1391.27	1.27	1.600	3.299	0.859	1.09	1.10	1.64	1.87	1.65	2.89						

Table 7. Variables used for TFP regressions, mean and standard error values, UK 1994-2007 (1/2)

	Industry	TFP (index mean)	Avg_age, tot	Avg_age, nat	Avg_age, migr	Share of migrants	Share of Highly Sk., tot	Share of Highly Sk., migr	Share of Highly Sk., nat	Δ Share of Highly Sk., migr	Δ Share of Highly Sk., nat	Δ Share of migrants	Δ Share of Highly Sk. Young, migr	Δ Share of Highly Sk. Young, nat
01-05	Agri., hunting, forestry & fishing	113.22	44.11	44.18	41.84	0.0279	0.0980	0.0080	0.0900	0.000000	0.000088	0.0008	0.0001	-0.0012
		14.75	0.98	109	3.44	0.0090	0.0193	0.0039	0.0164	0.000005	0.000032	0.0093	0.0021	0.01
10-14	Mining & quarrying	96.28	41.69	41.75	40.58	0.0522	0.1700	0.0315	0.1385	0.000008	0.000464	0.0020	0.0011	0.0033
		10.42	145	151	3.23	0.0198	0.0446	0.0142	0.0349	0.000059	0.000134	0.0238	0.0082	0.02
15-16	Food, bev. & tobacco	96.41	39.47	39.75	37.73	0.0840	0.1000	0.0191	0.0809	0.000004	0.000065	0.0105	0.0022	-0.0011
		5.05	105	140	145	0.0504	0.0238	0.0158	0.0122	0.000010	0.000017	0.0192	0.0065	0.01
17-19	Textile, leather & footwear	111.41	41.29	41.37	40.74	0.1218	0.0788	0.0204	0.0585	-0.000002	0.000080	-0.0106	-0.0009	-0.0016
		18.06	2.04	2.20	183	0.0136	0.0268	0.0106	0.0226	0.000042	0.000068	0.0241	0.0099	0.01
20	Wood, of wood & cork	94.77	39.18	39.18	40.04	0.0326	0.0567	0.0071	0.0496	0.000011	0.000232	0.0033	0.0013	-0.0010
		4.51	118	135	6.32	0.0173	0.0256	0.0084	0.0226	0.000035	0.000120	0.0165	0.0045	0.02
21-22	Pulp, paper, print. & publishing	98.87	40.03	40.16	38.22	0.0585	0.1805	0.0231	0.1574	0.000001	0.000130	-0.0014	0.0002	-0.0016
		2.51	131	145	156	0.0077	0.0331	0.0058	0.0281	0.000005	0.000048	0.0104	0.0043	0.01
24	Chemicals & chemical	105.61	40.10	40.21	38.77	0.0621	0.2515	0.0319	0.2195	0.000007	0.000306	0.0014	0.0010	-0.0040
		12.71	104	112	2.13	0.0197	0.0557	0.0134	0.0458	0.000018	0.000110	0.0157	0.0085	0.02
25	Rubber & plastics	98.77	39.50	39.49	40.02	0.0504	0.0681	0.0098	0.0583	0.000003	0.000100	0.0016	0.0009	-0.0017
		5.68	158	168	2.73	0.0172	0.0144	0.0060	0.0136	0.000012	0.000045	0.0145	0.0050	0.01
26	Other non-metallic mineral	108.25	40.85	40.86	42.01	0.0406	0.0832	0.0111	0.0721	0.000005	0.000196	0.0025	0.0010	-0.0005
		14.05	119	132	4.05	0.0210	0.0254	0.0101	0.0185	0.000052	0.000080	0.0210	0.0066	0.02
27	Basic metals	109.76	41.82	41.77	43.02	0.0426	0.0679	0.0096	0.0583	0.000001	0.000045	-0.0007	0.0004	-0.0003
		11.48	136	147	183	0.0076	0.0176	0.0044	0.0156	0.000004	0.000021	0.0071	0.0021	0.01
28	Fabricated metal products	104.96	41.51	41.64	40.63	0.0541	0.1071	0.0154	0.0917	0.000003	0.000087	0.0036	0.0016	-0.0015
		14.13	135	158	2.81	0.0257	0.0291	0.0107	0.0215	0.000005	0.000034	0.0118	0.0033	0.01
29	Machinery & equip.	122.11	39.51	39.52	39.65	0.0658	0.1822	0.0269	0.1553	0.000002	0.000109	-0.0004	0.0005	-0.0022
		25.74	148	158	109	0.0152	0.0376	0.0085	0.0300	0.000004	0.000050	0.0111	0.0070	0.01
30	Office, account. & comput. apparatus	102.75	41.02	41.00	41.63	0.0578	0.1049	0.0143	0.0906	0.000001	0.000070	-0.0005	0.0009	0.0006
		10.13	0.91	100	135	0.0104	0.0254	0.0062	0.0208	0.000003	0.000020	0.0111	0.0046	0.01
31	Electrical machinery & apparatus	97.31	39.42	39.43	39.50	0.0568	0.0881	0.0151	0.0730	0.000004	0.000126	0.0011	0.0011	0.0013
		6.53	145	155	2.23	0.0167	0.0264	0.0078	0.0197	0.000013	0.000054	0.0186	0.0047	0.01
32	Radio, TV & communication	111.38	39.70	39.75	38.23	0.0339	0.1741	0.0114	0.1626	0.000003	0.000369	0.0007	0.0012	0.0003
		6.69	0.86	0.88	3.01	0.0097	0.0277	0.0065	0.0258	0.000023	0.000091	0.0098	0.0057	0.02
33	Medical, precision & optical instruments	104.05	40.28	40.31	39.75	0.0338	0.0634	0.0085	0.0549	0.000000	0.000011	0.0025	0.0004	0.0005
		2.49	0.62	0.69	146	0.0111	0.0122	0.0040	0.0087	0.000000	0.000002	0.0054	0.0018	0.00
34	Motor vehicles, trailers & semi-trailers	109.38	38.53	38.53	38.79	0.0460	0.0516	0.0088	0.0428	0.000001	0.000029	0.0004	0.0003	-0.0001
		14.44	138	142	140	0.0105	0.0101	0.0032	0.0074	0.000003	0.000008	0.0088	0.0030	0.01
35	Other transport equip.	101.41	40.69	40.78	39.99	0.0743	0.1173	0.0259	0.0914	0.000001	0.000042	0.0023	0.0006	-0.0008
		3.40	125	143	138	0.0174	0.0190	0.0075	0.0125	0.000003	0.000012	0.0085	0.0041	0.01
36	Manufacturing, n.e.c.	105.15	36.47	36.42	37.30	0.0637	0.2098	0.0209	0.1889	0.000000	0.000026	0.0014	0.0006	0.0005
		4.62	0.47	0.49	0.47	0.0114	0.0234	0.0055	0.0186	0.000000	0.000004	0.0040	0.0022	0.01

Table 7. Variables used for TFP regressions, mean and standard error values, UK 1994-2007 (2/2)

Industry	TFP (index mean)	Avg_age, tot	Avg_age, nat	Avg_age, migr	of migrants	of Highly Sk., tot	Share of Highly Sk., migr	Share of Highly Sk., nat	Δ Share of Highly Sk., migr	Δ Share of Highly Sk., nat	Δ Share of migrants	Δ Share of Highly Sk. Young, migr	Δ Share of Highly Sk. Young, nat
55 Hotels & restaurants	96.61	34.05	33.84	35.46	0.1335	0.2507	0.0375	0.2132	0.000001	0.000068	0.0048	0.0017	-0.0011
	2.86	0.68	0.72	0.74	0.0286	0.0342	0.0120	0.0257	0.000002	0.000011	0.0108	0.0032	0.02
60-63 Transport & storage	111.74	41.24	41.39	39.99	0.0825	0.0821	0.0212	0.0610	0.000001	0.000015	0.0040	0.0012	0.0005
	7.85	1.16	1.36	1.16	0.0232	0.0178	0.0078	0.0111	0.000002	0.000003	0.0078	0.0036	0.00
64 Post & Telecomm.	139.33	39.60	39.61	39.60	0.0711	0.1225	0.0284	0.0941	0.000002	0.000055	0.0022	0.0011	0.0021
	27.24	0.90	0.97	1.32	0.0143	0.0322	0.0111	0.0223	0.000007	0.000013	0.0114	0.0044	0.01
65-67 Financial intermediation	113.04	36.46	36.49	36.31	0.0717	0.1998	0.0378	0.1621	0.000002	0.000052	0.0035	0.0022	0.0025
	10.09	0.85	0.93	1.03	0.0183	0.0510	0.0140	0.0385	0.000003	0.000013	0.0077	0.0042	0.01
70 Real estate activities	91.51	42.55	42.55	42.51	0.0698	0.1937	0.0262	0.1676	0.000002	0.000171	0.0031	0.0003	0.0018
	10.23	1.10	1.11	1.60	0.0131	0.0299	0.0074	0.0237	0.000007	0.000021	0.0099	0.0028	0.02
71-74 Renting of machinery, other business activities	103.23	40.00	40.17	38.54	0.0936	0.3148	0.0504	0.2645	0.000001	0.000039	0.0058	0.0021	0.0020
	4.87	0.85	0.98	0.60	0.0204	0.0374	0.0136	0.0244	0.000001	0.000002	0.0066	0.0039	0.01
75 Public admin. & defence; Compulsory social security	95.38	40.57	40.59	40.35	0.0518	0.1856	0.0185	0.1671	0.000000	0.000038	0.0019	0.0005	0.0018
	3.30	1.18	1.22	0.64	0.0090	0.0359	0.0061	0.0306	0.000001	0.000007	0.0062	0.0012	0.01
80 Education	88.07	43.41	43.52	41.94	0.0677	0.4356	0.0405	0.3951	0.000000	0.000068	0.0021	0.0005	0.0020
	9.85	0.41	0.43	0.47	0.0083	0.0066	0.0053	0.0067	0.000001	0.000003	0.0047	0.0018	0.01
85 Health and Social work	101.62	41.49	41.53	41.31	0.0887	0.1900	0.0385	0.1515	0.000000	0.000016	0.0036	0.0010	0.0010
	1.74	0.96	1.08	0.58	0.0179	0.0290	0.0119	0.0180	0.000000	0.000001	0.0045	0.0019	0.01
90-93 Other community, social & personal services	94.32	39.38	39.37	39.50	0.0656	0.2280	0.0268	0.2012	0.000000	0.000054	0.0016	0.0004	0.0020
	8.48	0.54	0.60	0.46	0.0096	0.0272	0.0051	0.0231	0.000001	0.000008	0.0086	0.0021	0.01
95 Private households with employed persons	.	43.65	45.08	33.87	0.1273	0.1377	0.0389	0.0989	0.000014	0.000207	-0.0045	-0.0007	-0.0067
	.	1.87	1.92	3.21	0.0244	0.0258	0.0160	0.0195	0.000073	0.000083	0.0394	0.0167	0.02
Total	104.37	40.25	40.34	39.59	0.0661	0.1531	0.0228	0.1303	0.000003	0.000112	0.0016	0.0008	-0.0001
	14.90	2.36	2.52	2.98	0.0319	0.0898	0.0147	0.0798	0.000023	0.000119	0.0142	0.0054	0.01

Table 8. Variables used for TFP regressions, mean and standard error values, France 1994-2007 (1/2).

	Industry	TFP (index mean)	Avg_age, tot	Avg_age, nat	Avg_age, migr	Share of migrants	Share of Highly Sk., tot	Share of Highly Sk., migr	Share of Highly Sk., nat	Δ Share of Highly Sk., migr	Δ Share of Highly Sk., nat	Δ Share of migrants	Δ Share of Highly Sk. Young, migr	Δ Share of Highly Sk. Young, nat
01-05	Agri., hunting, forestry & fishing	111.17	43.83	43.86	43.01	0.0351	0.0323	0.0020	0.0303	0.000000	0.000000	0.0003	0.0000	0.0011
		8.81	0.49	0.46	1.44	0.0066	0.0111	0.0014	0.0102	0.000000	0.000001	0.0080	0.0005	0.00
10-14	Mining & quarrying	71.84	42.65	42.63	43.25	0.0473	0.1155	0.0076	0.1079	-0.000005	0.000046	-0.0022	-0.0004	0.0091
		18.44	1.07	1.05	3.30	0.0174	0.0631	0.0069	0.0609	0.000054	0.000214	0.0215	0.0016	0.03
15-16	Food, bev. & tobacco	97.04	37.97	37.88	40.63	0.0325	0.0566	0.0022	0.0545	0.000000	0.000001	0.0015	0.0002	0.0026
		2.92	0.68	0.71	1.04	0.0044	0.0119	0.0018	0.0108	0.000001	0.000002	0.0084	0.0009	0.01
17-19	Textile, leather & footwear	115.79	41.44	41.47	41.33	0.0965	0.0580	0.0042	0.0538	0.000000	0.000005	-0.0058	-0.0001	0.0022
		14.44	1.56	1.57	2.47	0.0123	0.0253	0.0020	0.0239	0.000002	0.000010	0.0269	0.0024	0.01
20	Wood, of wood & cork	132.42	38.81	38.64	41.89	0.0506	0.0402	0.0008	0.0394	0.000001	0.000005	0.0004	0.0000	0.0023
		26.70	0.86	0.80	3.30	0.0125	0.0172	0.0017	0.0166	0.000005	0.000029	0.0210	0.0000	0.01
21-22	Pulp, paper, print. & publishing	105.07	40.18	40.11	42.47	0.0317	0.1650	0.0065	0.1585	0.000000	0.000006	-0.0009	-0.0002	0.0051
		4.86	0.87	0.87	2.14	0.0072	0.0341	0.0024	0.0346	0.000002	0.000010	0.0053	0.0010	0.01
24	Chemicals & chemical	96.54	40.03	39.97	41.52	0.0340	0.2014	0.0079	0.1934	0.000000	0.000008	-0.0003	0.0001	0.0068
		7.38	0.46	0.47	1.90	0.0119	0.0369	0.0032	0.0377	0.000003	0.000009	0.0096	0.0025	0.02
25	Rubber & plastics	169.16	39.08	38.93	41.52	0.0602	0.0788	0.0038	0.0750	0.000000	0.000003	0.0015	0.0000	0.0030
		48.44	0.78	0.80	2.12	0.0098	0.0248	0.0037	0.0224	0.000003	0.000010	0.0125	0.0028	0.01
26	Other non-metallic mineral	109.66	40.98	40.79	44.94	0.0507	0.0638	0.0023	0.0615	0.000001	0.000005	0.0006	0.0006	0.0026
		6.01	0.68	0.64	3.92	0.0137	0.0203	0.0036	0.0174	0.000005	0.000019	0.0129	0.0020	0.01
27	Basic metals	102.04	40.12	39.85	43.59	0.0718	0.0509	0.0023	0.0485	0.000000	0.000000	-0.0013	0.0000	0.0012
		2.73	0.89	0.96	1.63	0.0192	0.0069	0.0010	0.0071	0.000000	0.000003	0.0078	0.0014	0.00
28	Fabricated metal products	127.27	40.14	40.07	41.86	0.0383	0.0847	0.0045	0.0802	0.000000	0.000003	-0.0007	-0.0001	0.0029
		22.96	0.48	0.48	1.09	0.0066	0.0225	0.0029	0.0203	0.000002	0.000009	0.0064	0.0019	0.01
29	Machinery & equip.	127.84	39.66	39.61	41.00	0.0359	0.1679	0.0084	0.1595	0.000000	0.000002	-0.0002	0.0003	0.0019
		26.10	0.80	0.79	2.56	0.0042	0.0226	0.0041	0.0199	0.000002	0.000007	0.0061	0.0016	0.02
30	Office, account. & comput. apparatus	118.55	40.46	40.24	43.53	0.0580	0.1081	0.0058	0.1023	0.000000	0.000002	0.0000	0.0003	0.0044
		12.63	0.28	0.36	2.92	0.0126	0.0282	0.0028	0.0263	0.000001	0.000004	0.0052	0.0014	0.01
31	Electrical machinery & apparatus	111.30	39.60	39.47	42.27	0.0470	0.0614	0.0041	0.0573	0.000000	0.000005	0.0003	0.0002	0.0025
		10.31	0.70	0.68	2.59	0.0086	0.0163	0.0025	0.0160	0.000003	0.000010	0.0068	0.0017	0.01
32	Radio, TV & communication	126.06	41.40	41.37	44.19	0.0136	0.1396	0.0025	0.1371	0.000000	0.000003	0.0003	0.0000	-0.0005
		24.19	0.80	0.82	3.93	0.0050	0.0175	0.0019	0.0189	0.000004	0.000031	0.0074	0.0012	0.01
33	Medical, precision & optical instruments	95.78	39.50	39.08	42.34	0.1280	0.0342	0.0029	0.0313	0.000000	0.000000	0.0031	0.0001	0.0015
		2.66	0.29	0.26	0.50	0.0102	0.0070	0.0014	0.0060	0.000000	0.000000	0.0148	0.0007	0.00
34	Motor vehicles, trailers & semi-trailers	89.09	37.83	37.78	38.93	0.0460	0.0422	0.0034	0.0388	0.000000	0.000001	0.0006	0.0004	0.0013
		7.30	0.63	0.58	2.67	0.0091	0.0092	0.0015	0.0084	0.000001	0.000004	0.0102	0.0017	0.01
35	Other transport equip.	108.86	38.99	38.98	39.36	0.0434	0.1246	0.0093	0.1154	0.000000	0.000001	0.0015	0.0003	0.0051
		9.61	0.42	0.41	1.02	0.0052	0.0136	0.0015	0.0134	0.000000	0.000002	0.0088	0.0013	0.01
36	Manufacturing, n.e.c.	97.29	38.16	38.14	38.60	0.0432	0.1247	0.0050	0.1198	0.000000	0.000001	0.0016	0.0003	0.0047
		1.54	0.81	0.78	1.80	0.0037	0.0321	0.0022	0.0305	0.000000	0.000002	0.0071	0.0008	0.01

Table 8. Variables used for TFP regressions, mean and standard error values, France 1994-2007 (2/2).

	Industry	TFP (index mean)	Avg_age, tot	Avg_age, nat	Avg_age, migr	Share of migrants	Share of Highly Sk., tot	Share of Highly Sk., migr	Share of Highly Sk., nat	Δ Share of Highly Sk., migr	Δ Share of Highly Sk., nat	Δ Share of migrants	Δ Share of Highly Sk. Young, migr	Δ Share of Highly Sk. Young, nat
55	Hotels & restaurants	100.35	37.31	37.07	39.44	0.1017	0.0760	0.0119	0.0641	0.000000	0.000001	0.0053	0.0008	0.0036
		3.25	0.27	0.29	0.79	0.0057	0.0205	0.0056	0.0155	0.000001	0.000002	0.0167	0.0031	0.01
60-63	Transport & storage	111.28	39.87	39.79	41.66	0.0429	0.0863	0.0056	0.0808	0.000000	0.000001	0.0027	0.0002	0.0038
		6.98	0.58	0.63	0.99	0.0026	0.0173	0.0021	0.0157	0.000001	0.000001	0.0056	0.0015	0.01
64	Post & Telecomm.	153.83	42.28	42.33	37.58	0.0102	0.1616	0.0034	0.1582	0.000000	0.000004	0.0014	0.0003	0.0041
		44.62	0.46	0.47	3.93	0.0056	0.0342	0.0022	0.0324	0.000001	0.000006	0.0030	0.0013	0.01
65-67	Financial intermediation	101.64	41.24	41.28	38.69	0.0172	0.2826	0.0075	0.2751	0.000000	0.000004	0.0010	0.0003	0.0090
		3.31	0.62	0.64	142	0.0033	0.0451	0.0021	0.0435	0.000001	0.000004	0.0057	0.0020	0.02
70	Real estate activities	108.88	42.89	42.55	45.83	0.1052	0.1604	0.0054	0.1550	0.000000	0.000003	0.0019	0.0003	0.0045
		6.28	0.80	0.80	146	0.0188	0.0211	0.0027	0.0198	0.000002	0.000019	0.0188	0.0022	0.02
71-74	Renting of machinery, other business activities	93.27	38.75	38.64	40.20	0.0711	0.3251	0.0186	0.3065	0.000000	0.000001	0.0050	0.0010	0.0117
		5.13	0.44	0.46	104	0.0052	0.0294	0.0039	0.0258	0.000000	0.000001	0.0111	0.0018	0.03
75	Public admin. & defence; Compulsory social security	105.23	41.70	41.69	42.67	0.0091	0.1897	0.0017	0.1879	0.000000	0.000001	0.0005	0.0001	0.0062
		3.64	0.82	0.82	151	0.0011	0.0295	0.0006	0.0293	0.000000	0.000001	0.0017	0.0005	0.01
80	Education	89.51	41.44	41.50	39.16	0.0235	0.5265	0.0131	0.5134	0.000000	0.000002	0.0007	0.0002	0.0120
		6.83	0.80	0.77	2.38	0.0022	0.0741	0.0014	0.0741	0.000000	0.000003	0.0037	0.0015	0.03
85	Health and Social work	95.16	41.06	41.05	41.33	0.0244	0.1550	0.0054	0.1497	0.000000	0.000000	0.0014	0.0000	0.0027
		2.65	112	111	172	0.0021	0.0059	0.0010	0.0057	0.000000	0.000001	0.0038	0.0006	0.01
90-93	Other community, social & personal services	107.81	38.91	38.84	40.37	0.0479	0.2196	0.0135	0.2061	0.000000	0.000002	0.0015	0.0001	0.0086
		6.17	0.73	0.71	152	0.0059	0.0287	0.0019	0.0293	0.000001	0.000003	0.0078	0.0009	0.02
95	Private households with employed persons	108.83	43.56	43.57	43.45	0.1464	0.0370	0.0060	0.0310	0.000000	0.000001	0.0092	0.0003	0.0020
		4.93	0.81	0.82	138	0.0142	0.0152	0.0028	0.0131	0.000001	0.000004	0.0275	0.0020	0.01
	Total	109.62	40.33	40.24	41.55	0.0521	0.1323	0.0059	0.1264	0.000000	0.000004	0.0010	0.0002	0.0043
		24.80	182	185	2.92	0.0344	0.1071	0.0048	0.1043	0.000010	0.000040	0.0122	0.0016	0.01

Table 9. Variables used for TFP regressions, mean and standard error values, Germany 1996-2007 (1/2).

	Industry	TFP (index mean)	Avg_age, tot	Avg_age, nat	Avg_age, migr	Share of migrants	Share of Highly Sk., tot	Share of Highly Sk., migr	Share of Highly Sk., nat	Δ Share of Highly Sk., migr	Δ Share of Highly Sk., nat	Δ Share of migrants	Δ Share of Highly Sk. Young, migr	Δ Share of Highly Sk. Young, nat
01-05	Agri., hunting, forestry & fishing	151.76	43.35	43.60	37.76	0.0427	0.0565	0.0024	0.0541	0.000018	-0.000959	-0.0002	0.0000	-0.0011
		26.68	0.29	0.30	0.83	0.0040	0.0060	0.0009	0.0054	0.000801	0.004233	0.0052	0.0008	0.00
10-14	Mining & quarrying	99.53	41.50	41.84	38.79	0.1068	0.0838	0.0068	0.0770	0.000645	-0.001498	-0.0112	0.0003	-0.0013
		9.60	141	133	185	0.0264	0.0135	0.0035	0.0109	0.001398	0.009579	0.0135	0.0020	0.01
15-16	Food, bev. & tobacco	101.58	39.23	39.58	36.37	0.1074	0.0400	0.0036	0.0363	0.000150	0.000816	0.0011	0.0001	-0.0002
		2.77	0.44	0.38	104	0.0033	0.0034	0.0011	0.0032	0.001281	0.003678	0.0068	0.0008	0.00
17-19	Textile, leather & footwear	118.80	41.86	42.11	40.32	0.1378	0.0601	0.0080	0.0522	0.000181	-0.000372	-0.0074	0.0000	-0.0001
		13.39	0.65	0.55	162	0.0081	0.0100	0.0027	0.0085	0.002831	0.006150	0.0152	0.0014	0.00
20	Wood, of wood & cork	118.56	39.26	39.27	39.12	0.0841	0.0367	0.0037	0.0330	-0.000358	-0.001038	-0.0084	-0.0002	-0.0006
		11.30	1.17	1.19	190	0.0151	0.0055	0.0019	0.0059	0.001305	0.006821	0.0159	0.0009	0.00
21-22	Pulp, paper, print. & publishing	101.20	40.60	40.84	38.21	0.0894	0.1221	0.0098	0.1123	0.000267	0.002989	-0.0013	0.0002	0.0000
		4.74	0.26	0.25	0.72	0.0075	0.0128	0.0024	0.0109	0.002041	0.006002	0.0090	0.0015	0.00
24	Chemicals & chemical	126.28	40.57	40.69	39.24	0.0818	0.1745	0.0133	0.1612	0.000544	0.001389	-0.0023	0.0004	-0.0005
		19.79	0.55	0.55	0.69	0.0080	0.0113	0.0029	0.0092	0.004268	0.013228	0.0072	0.0033	0.01
25	Rubber & plastics	109.19	39.74	39.97	38.46	0.1476	0.0685	0.0066	0.0619	0.000641	0.001872	-0.0033	0.0002	0.0002
		10.21	0.55	0.47	145	0.0154	0.0078	0.0033	0.0069	0.002806	0.008060	0.0200	0.0017	0.01
26	Other non-metallic mineral	113.08	40.91	41.08	39.53	0.1088	0.0723	0.0055	0.0668	0.000319	0.000128	-0.0050	0.0001	-0.0004
		11.79	0.82	0.82	136	0.0129	0.0093	0.0014	0.0085	0.001539	0.011401	0.0153	0.0007	0.01
27	Basic metals	109.73	40.05	40.23	38.88	0.1265	0.0524	0.0039	0.0486	0.000238	-0.000241	-0.0033	0.0001	-0.0008
		4.84	0.53	0.45	114	0.0092	0.0033	0.0010	0.0035	0.001044	0.003616	0.0081	0.0005	0.00
28	Fabricated metal products	105.95	40.31	40.34	40.03	0.0888	0.1361	0.0081	0.1280	0.000266	0.000079	-0.0030	0.0003	-0.0015
		5.00	0.44	0.38	132	0.0066	0.0072	0.0020	0.0063	0.002240	0.006010	0.0054	0.0017	0.00
29	Machinery & equip.	132.35	39.45	39.57	38.20	0.0925	0.1933	0.0170	0.1764	0.000142	-0.001096	-0.0028	0.0003	-0.0026
		28.75	0.69	0.70	0.69	0.0070	0.0077	0.0027	0.0054	0.003229	0.011302	0.0082	0.0024	0.01
30	Office, account. & comput. apparatus	115.90	39.15	39.20	38.84	0.1477	0.1339	0.0129	0.1210	0.001345	0.008709	0.0009	0.0009	0.0043
		14.16	0.52	0.56	0.53	0.0145	0.0210	0.0032	0.0182	0.001708	0.007134	0.0049	0.0012	0.00
31	Electrical machinery & apparatus	105.19	39.30	39.41	38.05	0.0810	0.0520	0.0051	0.0469	0.000417	-0.001169	0.0001	0.0003	-0.0006
		4.90	0.90	0.91	1.10	0.0056	0.0051	0.0019	0.0051	0.001452	0.005242	0.0093	0.0011	0.00
32	Radio, TV & communication	123.02	41.05	41.17	37.05	0.0289	0.1635	0.0053	0.1581	0.001228	0.002253	0.0011	0.0007	0.0002
		10.20	0.33	0.37	2.49	0.0049	0.0171	0.0038	0.0140	0.001834	0.013513	0.0056	0.0013	0.01
33	Medical, precision & optical instruments	98.07	38.91	39.00	37.94	0.0857	0.0714	0.0042	0.0672	-0.000003	-0.001827	-0.0023	0.0000	-0.0015
		185	0.88	0.89	0.85	0.0040	0.0026	0.0008	0.0027	0.001153	0.002893	0.0063	0.0009	0.00
34	Motor vehicles, trailers & semi-trailers	110.10	37.13	37.45	33.84	0.0871	0.0371	0.0040	0.0331	0.000202	0.001081	0.0008	0.0002	0.0002
		9.81	0.68	0.64	135	0.0051	0.0044	0.0009	0.0037	0.001195	0.004295	0.0072	0.0010	0.00
35	Other transport equip.	116.67	40.57	40.81	37.66	0.0768	0.0924	0.0106	0.0818	0.000457	0.000635	-0.0001	0.0000	-0.0011
		11.55	0.61	0.60	103	0.0069	0.0083	0.0022	0.0066	0.002114	0.010746	0.0116	0.0014	0.00
36	Manufacturing, n.e.c.	105.18	39.76	40.09	35.52	0.0735	0.0578	0.0054	0.0524	0.000312	0.000630	0.0018	0.0002	-0.0003
		3.00	0.37	0.37	0.88	0.0076	0.0058	0.0015	0.0045	0.001031	0.002163	0.0029	0.0006	0.00

Table 9. Variables used for TFP regressions, mean and standard error values, Germany 1996-2007 (2/2).

	Industry	TFP (index mean)	Avg_age, tot	Avg_age, nat	Avg_age, migr	Share of migrants	Share of Highly Sk., tot	Share of Highly Sk., migr	Share of Highly Sk., nat	Δ Share of Highly Sk., migr	Δ Share of Highly Sk., nat	Δ Share of migrants	Δ Share of Highly Sk. Young, migr	Δ Share of Highly Sk. Young, nat
55	Hotels & restaurants	95.66	37.36	37.67	36.52	0.2658	0.0351	0.0128	0.0223	0.000652	0.000641	0.0062	0.0003	0.0001
		2.90	0.21	0.44	0.72	0.0046	0.0036	0.0021	0.0021	0.002771	0.001830	0.0110	0.0019	0.00
60-63	Transport & storage	115.10	40.86	41.17	37.75	0.0893	0.0716	0.0089	0.0627	0.000509	0.001809	0.0022	0.0003	0.0007
		7.00	0.78	0.76	1.20	0.0043	0.0082	0.0023	0.0062	0.002670	0.005233	0.0059	0.0022	0.00
64	Post & Telecomm.	149.04	39.20	39.52	34.35	0.0622	0.1165	0.0080	0.1086	0.000349	-0.000509	0.0019	0.0001	-0.0019
		26.52	0.98	1.01	1.12	0.0086	0.0088	0.0023	0.0083	0.003522	0.009174	0.0068	0.0029	0.01
65-67	Financial intermediation	97.88	39.45	39.56	36.04	0.0323	0.1572	0.0081	0.1491	0.000315	0.004815	0.0004	0.0002	0.0003
		7.34	0.95	0.97	1.28	0.0034	0.0170	0.0020	0.0157	0.001550	0.007822	0.0026	0.0012	0.01
70	Real estate activities	105.82	44.20	44.37	40.97	0.0514	0.1621	0.0075	0.1546	0.001286	0.005782	0.0042	0.0007	0.0012
		2.26	0.73	0.72	1.80	0.0103	0.0123	0.0034	0.0104	0.002704	0.012366	0.0127	0.0019	0.01
71-74	Renting of machinery, other business activities	76.42	39.43	39.65	37.19	0.0909	0.2959	0.0213	0.2746	0.001629	0.014986	0.0056	0.0011	0.0054
		9.48	0.47	0.46	0.87	0.0079	0.0111	0.0038	0.0096	0.002169	0.009517	0.0047	0.0020	0.01
75	Public admin. & defence; Compulsory social security	104.42	40.35	40.35	40.36	0.0185	0.2249	0.0027	0.2222	0.000150	0.002841	-0.0003	0.0001	-0.0008
		3.39	0.91	0.92	0.97	0.0016	0.0292	0.0006	0.0291	0.000568	0.022179	0.0023	0.0004	0.01
80	Education	96.74	42.51	42.67	39.22	0.0462	0.5359	0.0230	0.5128	0.001357	0.004603	0.0023	0.0007	0.0019
		4.48	0.41	0.45	0.52	0.0081	0.0146	0.0052	0.0167	0.002428	0.012782	0.0045	0.0017	0.01
85	Health and Social work	111.28	38.79	38.87	37.39	0.0576	0.1694	0.0084	0.1610	0.000337	0.004561	0.0005	0.0001	-0.0006
		3.88	1.00	0.99	1.11	0.0033	0.0061	0.0013	0.0053	0.000918	0.005003	0.0020	0.0007	0.00
90-93	Other community, social & personal services	96.09	40.67	40.98	37.18	0.0830	0.1884	0.0173	0.1710	0.000849	0.002843	0.0014	0.0004	-0.0006
		2.62	0.47	0.43	1.03	0.0045	0.0075	0.0027	0.0052	0.003182	0.007823	0.0067	0.0018	0.00
95	Private households with employed persons	101.93	43.87	45.16	36.34	0.1469	0.0329	0.0148	0.0181	0.001398	0.000968	0.0070	0.0007	0.0003
		3.25	0.98	0.98	2.63	0.0200	0.0090	0.0061	0.0058	0.004888	0.006515	0.0231	0.0047	0.00
	Total	110.42	40.31	40.54	37.90	0.0913	0.1231	0.0090	0.1142	0.000528	0.001857	-0.0004	0.0003	-0.0001
		18.94	1.77	1.85	2.09	0.0478	0.1012	0.0059	0.0976	0.002274	0.009202	0.0104	0.0017	0.01

Appendix 2 - Data description

KLEMS

Patents data come from the PATSTAT-KITES database

PATSTAT (EPO Worldwide PATent STATistical Database) is a patent database, held by the European Patent Office (EPO) developed in cooperation with the World Intellectual Property Organisation (WIPO), the OECD and Eurostat. PATSTAT provides raw patent data coming from around 90 patent offices worldwide, including, of course, the most important and largest ones such as the European Patent Office (EPO) and the United States Patent and Trademark Office (USPTO). The data set includes the full set of bibliographic variables concerning each patent application. PATSTAT IS provided in a raw format. Data coming from PATSTAT has, therefore, been thoroughly elaborated by KITES (Bocconi University: http://db.kites.unibocconi.it/) to produce a cleaned and harmonized database. Data process-ing consisted mainly in a thorough work of cleaning and standardization of rough information provided by the EPO. The aggregation of patent technological classifications (so called IPC classes) into NACE Rev. 1 fields follows Schmoch et al. (2003)[22]

UK Labour Force Survey

The British Quarterly Labour Force Survey (QLFS) is a quarterly sample survey of households living at private addresses in Great Britain. The QLFS is conducted on a quarterly basis and aims to obtain a sample of around 60,000 households every quarter. Since 1992 respondents are interviewed in five successive waves, thus approximately a fifth of the sample in each quarter will contain individuals from each of the five waves. Every quarter one wave of approximately 12,000 leaves the survey and a new wave enters. The rotational element to the QLFS creates an 80 percent overlap between quarters and thus 20 percent of the sample enter and exit the survey each quarter. In 2006 the QLFS moved from seasonal (spring, summer, autumn etc.) to calendar quarters (Jan.-March etc.).

The survey contains data on: employment and self-employment; full-time and part-time employment; second jobs; employment by age and sex; ILO unemployment by age and sex; economic activity by age and sex; occupations and industry sectors; regional economic activity; average actual weekly hours of work (by industry sector); economic inactivity by age and sex; economic inactivity by reason including discouraged workers; temporary employees; part-time and self-employed by occupation/industry; average actual weekly hours of work; ILO unemployment by occupation/industry; duration of ILO unemployment; average gross earnings by occupation, industry sector/region; ethnic group economic activity; household population by age and sex; economic activity for counties and larger Unitary Authorities and Local Authority Districts; long-term unemployed by occupation and industry sector; labour market structure.

QLFS contains information on earnings just after 1993; pre-1998, earnings data is available only for fifth wave respondents, post 1998 earnings data is collected in the first and in the final wave; country of birth within the UK only began to be collected in QLFS from 2001

Coverage Spatial: UK, Standard Regions

Coverage Temporal: 1992-2011

[22] ftp://ftp.cordis.europa.eu/pub/indicators/docs/ind_report_isi_ost_spru.pdf

French Labor Force Survey

The French Labor Force Survey was launched in 1950 and applied in 1982 as an annual survey. Redesigned in 2003, the survey is a continuous survey providing quarterly results. The survey covers private households in metropolitan France. It includes a part of the population living in collective households, persons who have family ties with private households. Participation in the survey is compulsory. The resident population comprises persons living in the French metropolitan territory.

The household concept used is that of the ‘dwelling household’: a household means all persons living in the same dwelling. It may consist of a single person or of two families living in the same dwelling.

The survey provides longitudinal data on households and individuals. Persons aged 15 years or over are interviewed. Data refer to the number of persons who were working during the survey week including employees, self-employed as well as family workers. Data include persons who have a job but are not at work due to illness (less than 1 year), vacation, labour dispute, educational leave, etc.

Coverage Spatial: France (II de France, the overseas departments and territories are excluded), Districts.

Coverage Temporal: 1968-2011 (quarterly)

German Microcensus

The microcensus provides official statistics of the population and the labor market in Germany. The Labor Force Survey of the European Union (EU Labor Force Survey) forms an integral part of the microcensus. The microcensus supplies statistical information in a detailed subject-related and regional breakdown on the population structure, the economic and social situation of the population, families, consensual unions and households, on employment, job search, education/training and continuing education/training, the housing situation and health. Furthermore, wage information is only given in intervals. The German Microcensus includes 1% of the resident population in the former West Germany, and is a large, representative, random sample containing comprehensive information on individual and household characteristics.

Coverage Spatial: DE, NUTS 3.

Coverage Temporal: 1971-2009.

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